MODERN PLASTICS

POLYPROPYLENE: where is it headed? *p. 72*

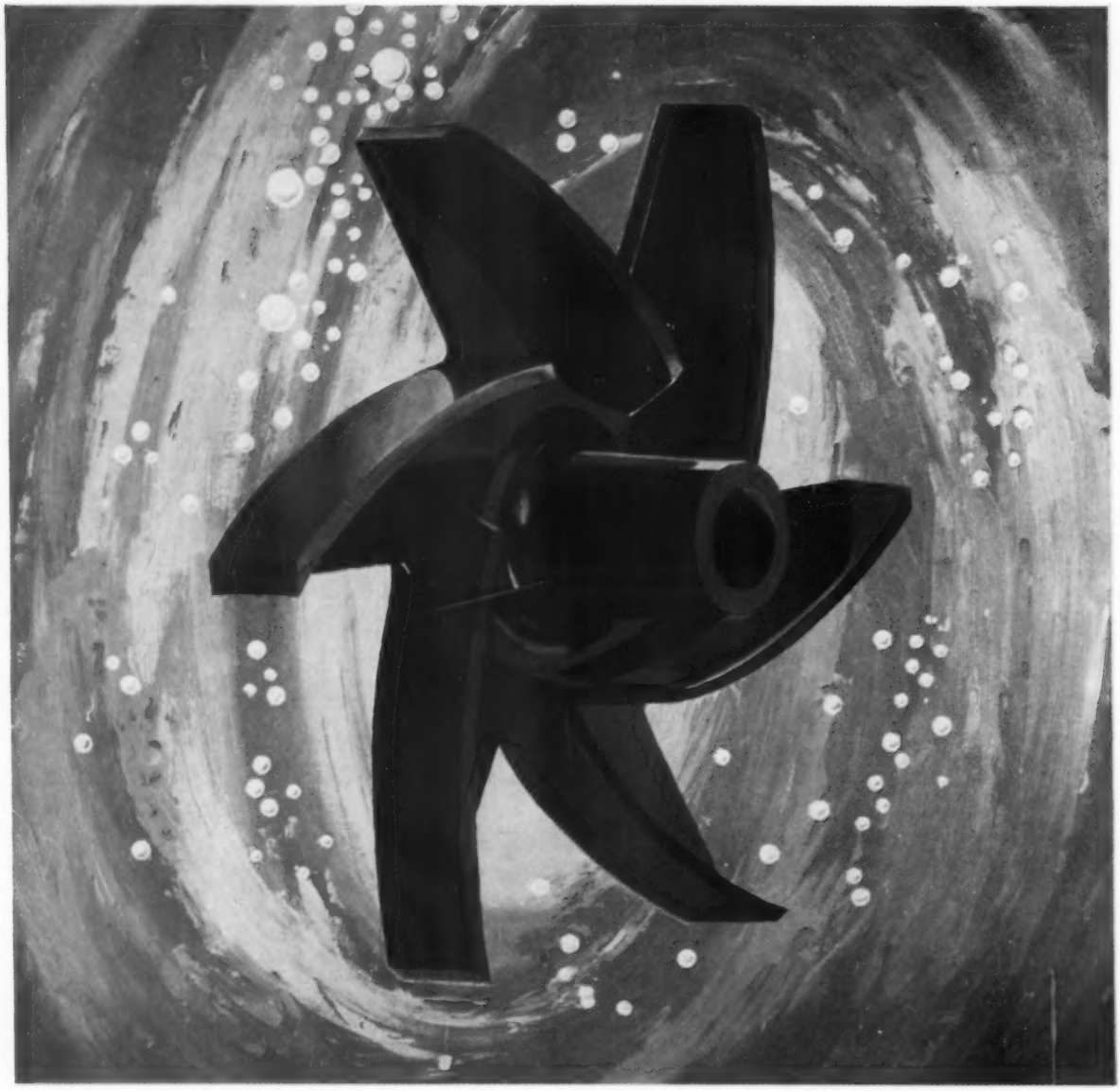
RP-urethane foam: new versatile partnership *p. 78*

Booming market for high-density PE in beverage cases *p. 88*

A guide to ultrasonic sealing equipment *p. 95*

AUGUST 1961

One of a series directed to IDEA-MEN



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MODERN PLASTICS

Volume 38, Number 12 **August 1961**

• THE PLASTISCOPE

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• EDITORIAL

New concept in international service . **71**

Recent opening of new service laboratories in Switzerland by two U.S. suppliers may be the start of an important trend. Such overseas technical service facilities can speed plastics growth and development world-wide, aid underdeveloped areas.

• GENERAL

Polypropylene: where is it going? . . **72**

This month's cover story: With markets in the offing that may total over 500 million lb. by 1965, industry attention is focusing on the polypropylenes —their advantages and limitations. This article, the first in a series, examines market potentials and resolves some of the conflicting claims as to the materials' properties. The position in the over-all picture of each current—and possible future—supplier of polypropylene is spelled out.

No sag design in phenolic laminate **77**

Called on to redesign fan blades to resist sagging in lengths over 14 feet, one manufacturer has developed a unique technique for building up the blades with layers of phenolic-fabric laminate that ensures even distribution of stresses.

Versatile partnership: reinforced plastics-urethane foam **78**

Two of the industry's newer materials—RP and urethane foam—team up in three different applications that highlight the combination's versatility in terms of design and economics. The three cases in point: a military shelter, a ladder, and an ice cream truck. Each of these applications involves a different production technique in order to meet specific end-user requirements.

For 1/4-scale model: full-scale engineering **82**

How engineering know-how was put to work in the production of over 300 molded precision parts of impact styrene that go into an exact-scale model kit of an automobile engine. There's a difference too—the model, when assembled, actually works.

Prepreg licks tough wiring problem . **85**

A new concept in harnesses for wiring uses polyester-glass prepreg materials. Result: a savings in space and weight over conventional laced harness; superior electrical performance; and less likelihood of damage to the wiring system.

For quality printing— "photopolymer" plates **86**

After 10 years of development, a new type of printing plate based on a monomer that can be polymerized simply by exposure to ultra-violet light is being readied to go into the printing industry. Properties show considerable promise—and volume is expected to be extremely large.

Beverage cases: coming market for high-density PE **88**

The number of new producers turning out polyethylene cases for beer, milk, or soft drinks underline predictions that the market may eventually account for annual resin sales of 100 million pounds. Performance of PE cases is superior to conventional units and now the economics, as spelled out in this article, are swinging in their favor. Success in this area can push polyethylene into similar volume markets for tote boxes as well as other shipping cases.

New Developments **131**

ABS-foam liners for reefer walls (p. 131); Styrene-foam portable beverage cooler . . . Phenolic control for washer . . . Three of PE—sirup dispenser, folding shovel, and auto radiator overcap (p. 134); Acrylic-enclosed street bridge . . . Acetal arc chute (p. 136).

• ENGINEERING SECTION

A guide to ultrasonic sealing equipment **95**

From a laboratory curiosity of several years back, the science of ultrasonics is emerging as an important source of energy for the plastics industry. Its

latest use: the welding or bonding of plastic film and fabrics. Here is a complete run-down on available types of equipment—how they operate and what you can expect of them.
By Howard Deans

Molds for encapsulation **103**

This second in a series on equipment for embedment processes offers a selection guide to the types of molds used in the production of embedded electronic packages. Fixtures and finishing operations are also covered.
By C. A. Harper

• TECHNICAL SECTION

Effect of physical treatments on the stability of polyamides **113**

Many forces influence the deterioration of organic polymers. Physical treatment by itself is not sufficient to heat stabilize nylon effectively. How the proper physical treatment (*e.g.,* quenching and drawing) combined with the use of proper additives can help prevent deterioration in polyamides is discussed.
By M. M. Epstein and C. W. Hamilton

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Coming up . . .

Our September lead provides an up-to-date progress report on the spray-up technique as it applies to reinforced plastics. Who is in the field and what they are doing is spelled out . . . Powder polyethylene used as an unusual art medium . . . Case study of a molded PP chair—its economics and performance record . . . A run-down on the techniques developed by a major pen manufacturer to turn out precision plastics parts at mass production rates . . . Engineering lead: Cast vs. molded epoxy encapsulations . . . Technical lead: Thermal properties of reinforced plastics . . . Also in the works: Urethane foams . . . Filament winding goes commercial . . . Special color effects.

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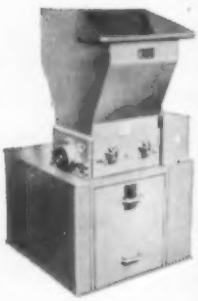

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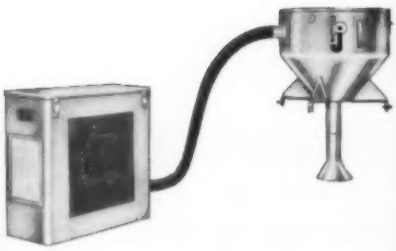

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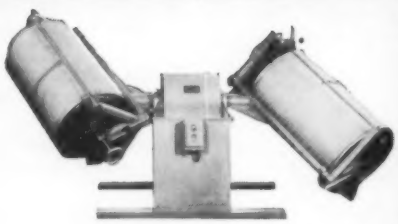

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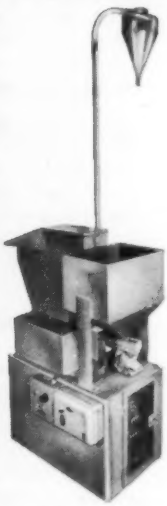

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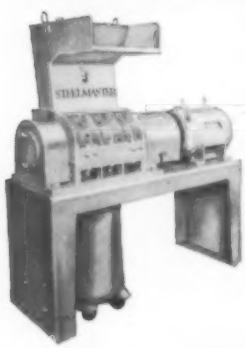

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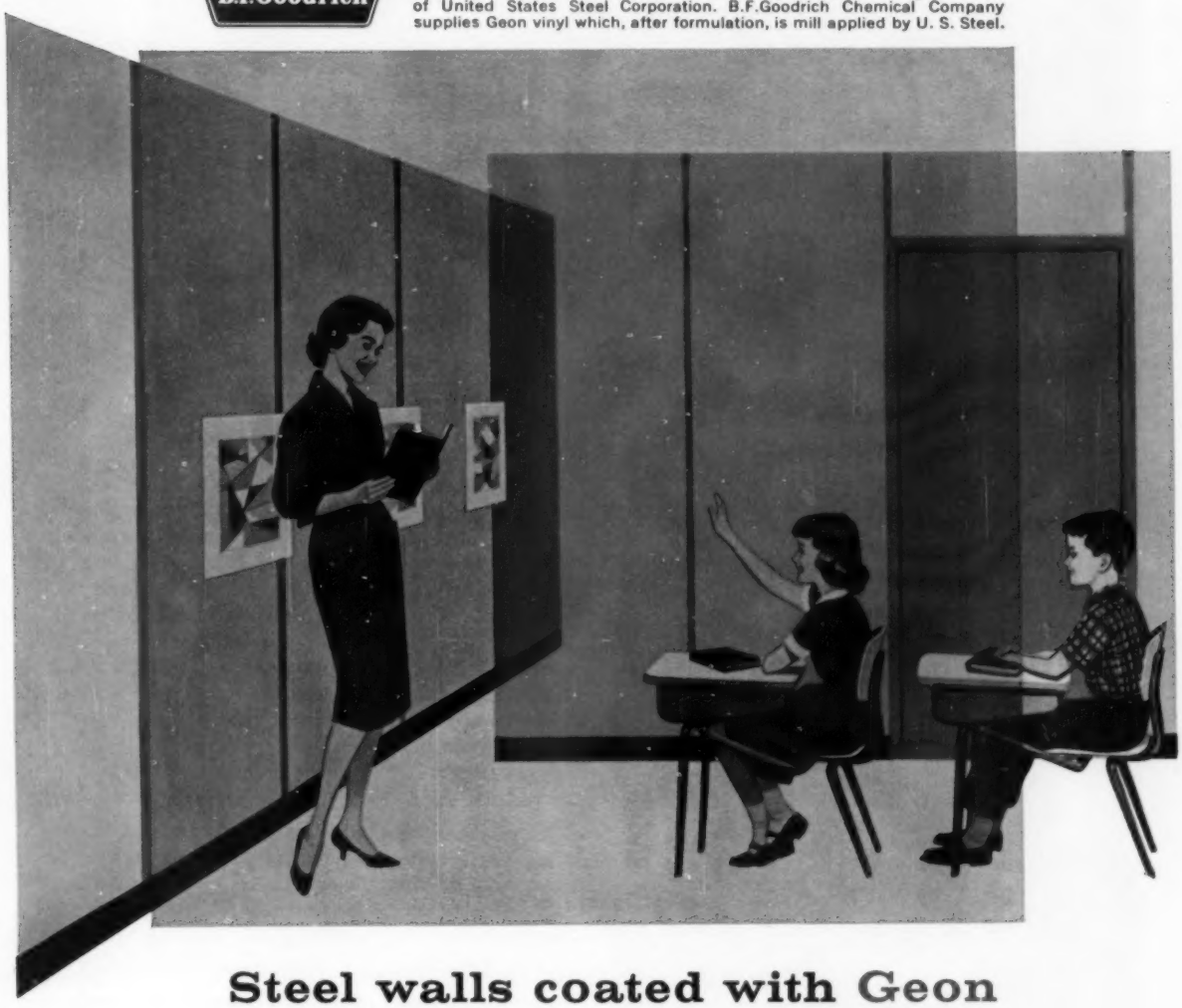

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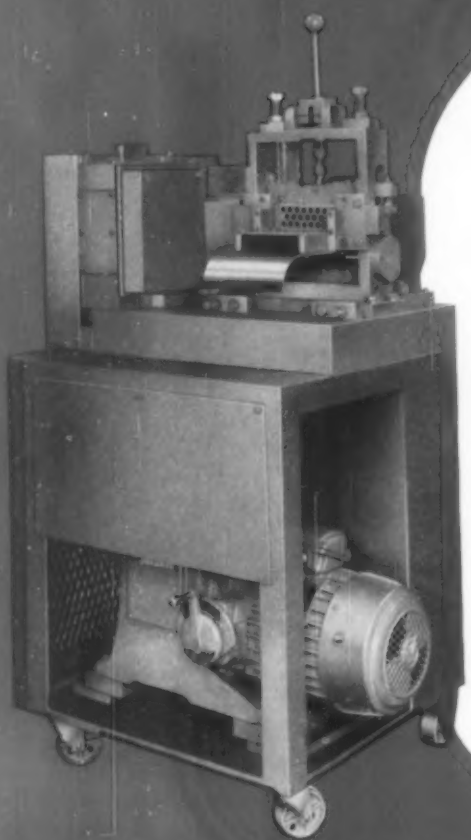

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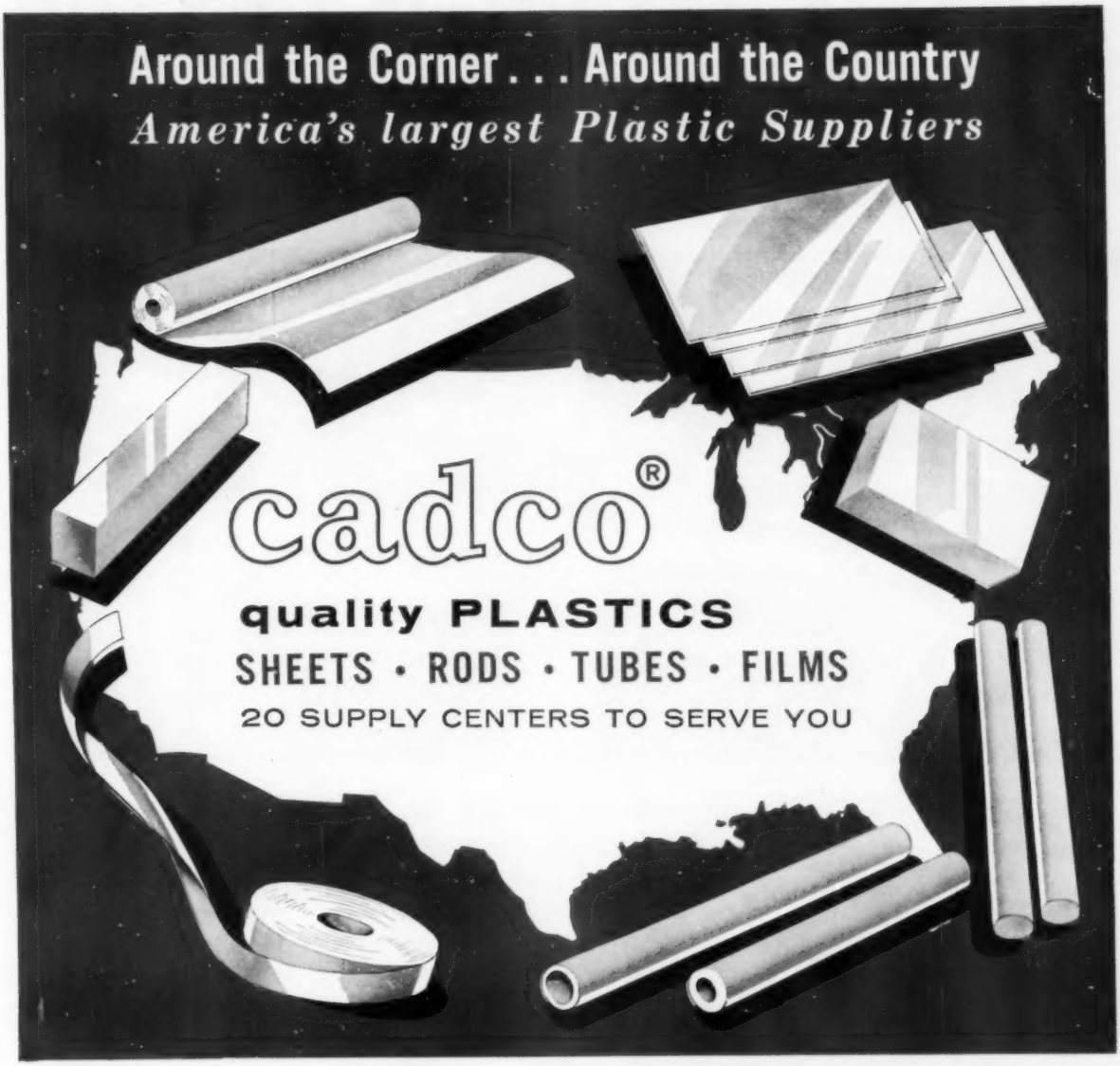

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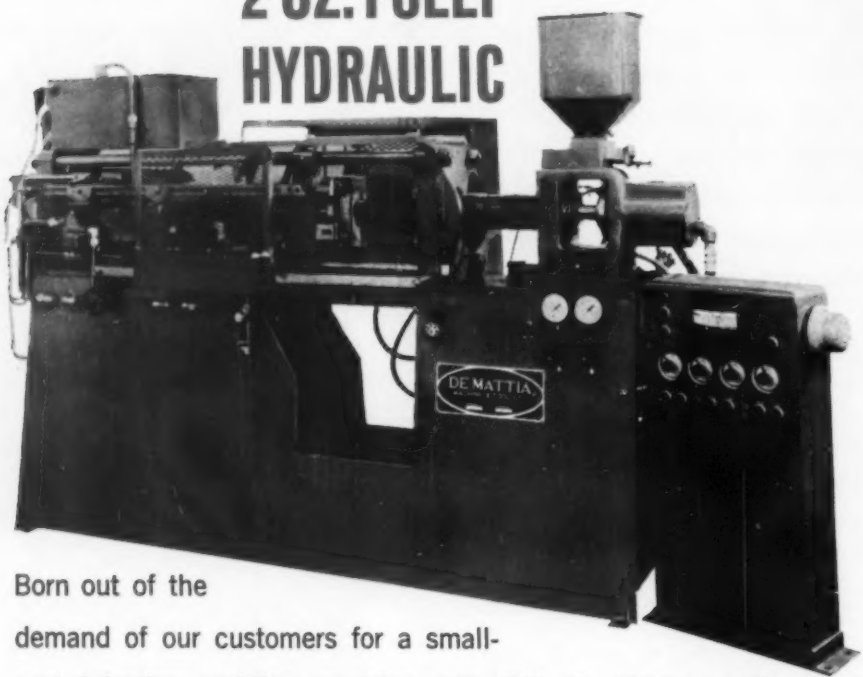

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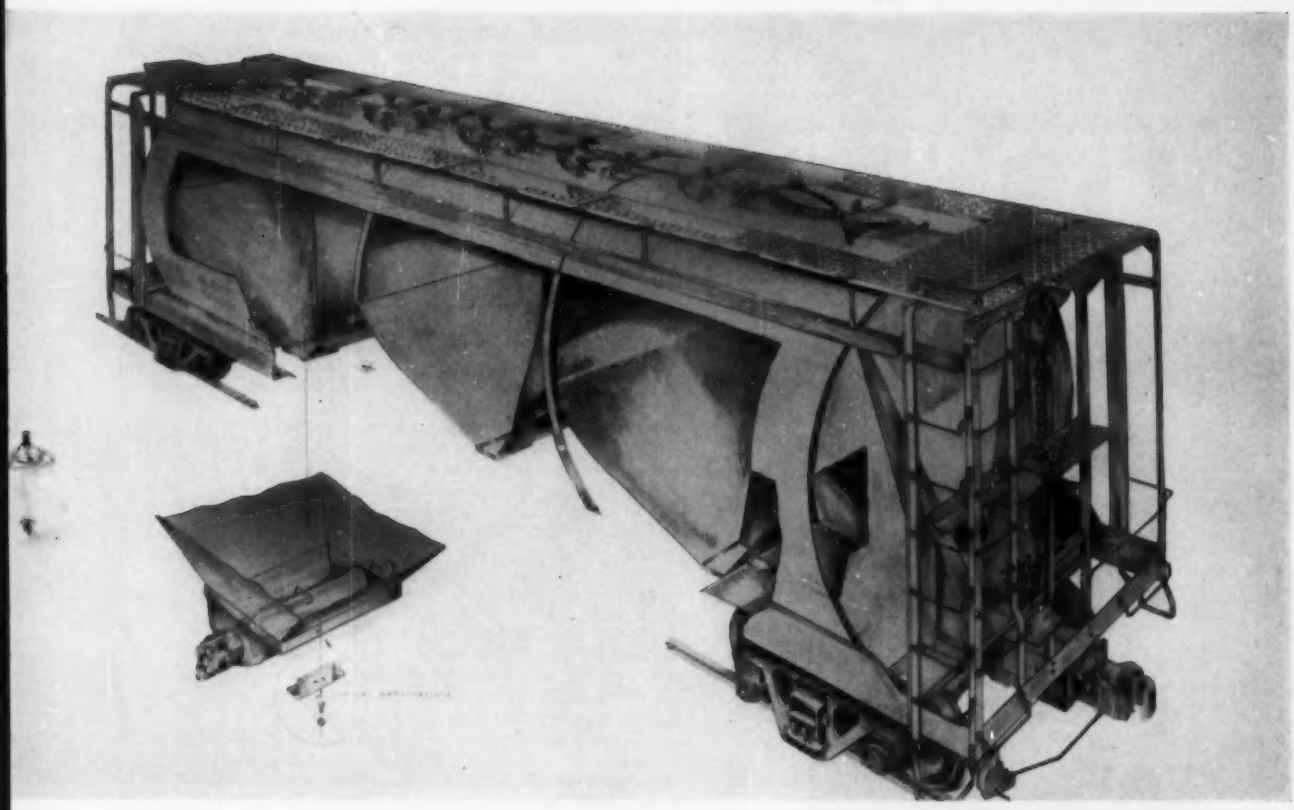

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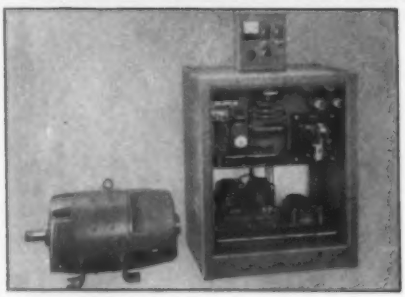
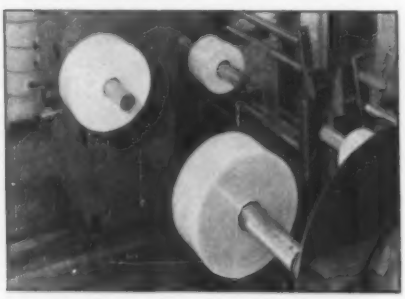


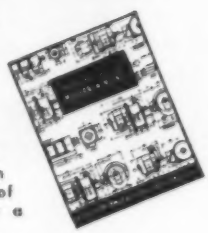
Hobbs Vers-a-wind Drive with Control Panel



The Hobbs Vers-a-wind in use at Turex Plastics Company, Nasonville, Rhode Island.

LITERATURE

The complete line of Hobbs Center-Shaft Web Winding and Unwinding Drives and Hobbs Winding Machines is described and illustrated in "Principles and Practices of Modern Winding". Send for a copy free of all obligations.



TYPE DCS VERS-A-WIND SPEED CONTROL DRIVE

Feedback dancer roll of very light construction operates a transducer which converts mechanical motion to an electrical impulse. This regulates the armature voltage of a DC shunt motor, thus controlling the output speed. Static type control increases reliability and reduces maintenance. Air pressure on dancer roll (which determines the tension) is adjustable. A variation of this type involves varying the field by the feedback principle and varying the armature voltage by a synchronizing tach signal.

Applications are in front of calenders, when rubber and plastic sheeting must be wound under light tension; for windup on any machine where roll weight becomes a large user of the total required torque; when friction in present winding equipment is extremely high; in front of extruders when tremendous speed changes, variable widths and variable diameter buildups are required; when DC power is not available from the process machine to synchronize the winding operation.

TYPE DCT TENSION CONTROL DRIVE

Controls preset tension by controlling the field current with a saturable reactor. Strength of field automatically adjusted to hold armature current constant for any one tension setting. As roll builds up, armature current tries to build up. However, by feedback control, field strength is increased and armature current is held constant at lower r.p.m. Torque output is increased to compensate for increased roll diameter. Maximum constancy of tension over large buildup range. Accuracy of ±2% over 8:1 or even 10:1 buildup. Used when a DC supply is not available from process machine and synchronization is unnecessary. For each change of processing speed, armature control must be adjusted.

TYPE DCTA TENSION CONTROL DRIVE

Similar to Type DCT, but is designed for process machines equipped with DC powered main drive systems, either rotary (M-G sets) or static (rectified). Armature of winding motor may be paralleled to armature of main drive motor for synchronization. Automatic control separately powers the field and provides winding characteristic.

TYPE DCTS TENSION CONTROL DRIVE

Also similar to Type DCT, but designed for process machines without DC main drives where synchronization is required. Armature supply is automatically controlled for synchronization by signal from a tach generator, which produces the winding characteristic.

Types DCT, DCTA and DCTS are recommended in all instances where a dancer roll affects the material adversely or where the ultimate in accuracy of control is desired.

THE HOBBS LINE INCLUDES 5 OTHER TYPES OF DRIVES —

— Standard CHP, NTJ with Synchronization, APF Progressive Friction, Standard HG Unwind and HG Unwind with Synchronization. Descriptive literature on request.

AIR AND MECHANICAL BRAKES

For unwind applications, alternate air or mechanical brakes can be furnished for automatic or manual control of unwind tension.

WINDING ACCESSORIES INCLUDE —

— web guides, castered bases, mandrels, "Center-Loc" core holders, conventional core chucks, special core chucks, and slitting attachments.

ALSO COMPLETE WINDING MACHINES, INCLUDING —

— light, medium and heavy duty single shaft; medium and heavy duty two-shaft staggered; medium and heavy duty three-shaft staggered; medium duty four-shaft staggered; two-shaft cantilevered fixed shaft and turret; light, medium and heavy duty two-shaft turret, heavy duty two-station shaftless turret; light and medium duty four-shaft duplex turret, and heavy duty three-shaft turret. Type of winding drive used is selected on basis of process specifications and application.

HOBBS MANUFACTURING COMPANY

25H Salisbury Street, Worcester 5, Mass.

Direct Sales Offices in Irvington, N.J., Columbus, O., Chicago, Ill. and Los Angeles, Calif. Representatives in Greenville, S.C. and Toronto, Ont., Can.

EST 1852

WINDERS · HAND & POWER SHEARS · SLITTERS · AUTOMATIC CUTTERS · DIE PRESSES

Natco Screw-Ram Improves Cycolac Helmet Production

. . . says Mr. Jim Spiros, Production Superintendent, Metal Specialty Company

THE MOLDER'S MOLDING MACHINE

"We decided to find out if Natco's reciprocating screw preplasticizing machine would improve our helmet production. For three days we simulated production on Natco's 400EX90 test machine, using our mold, material, operators and chillers. The results were fantastic! Quick color change . . . high plasticizing rate . . . better quality parts with less strain and high gloss . . . lower injection pressures . . . high speed molding using 100° F. less stock temperature! We molded both injection and extrusion grades of material with no apparent difference in molding cycles."

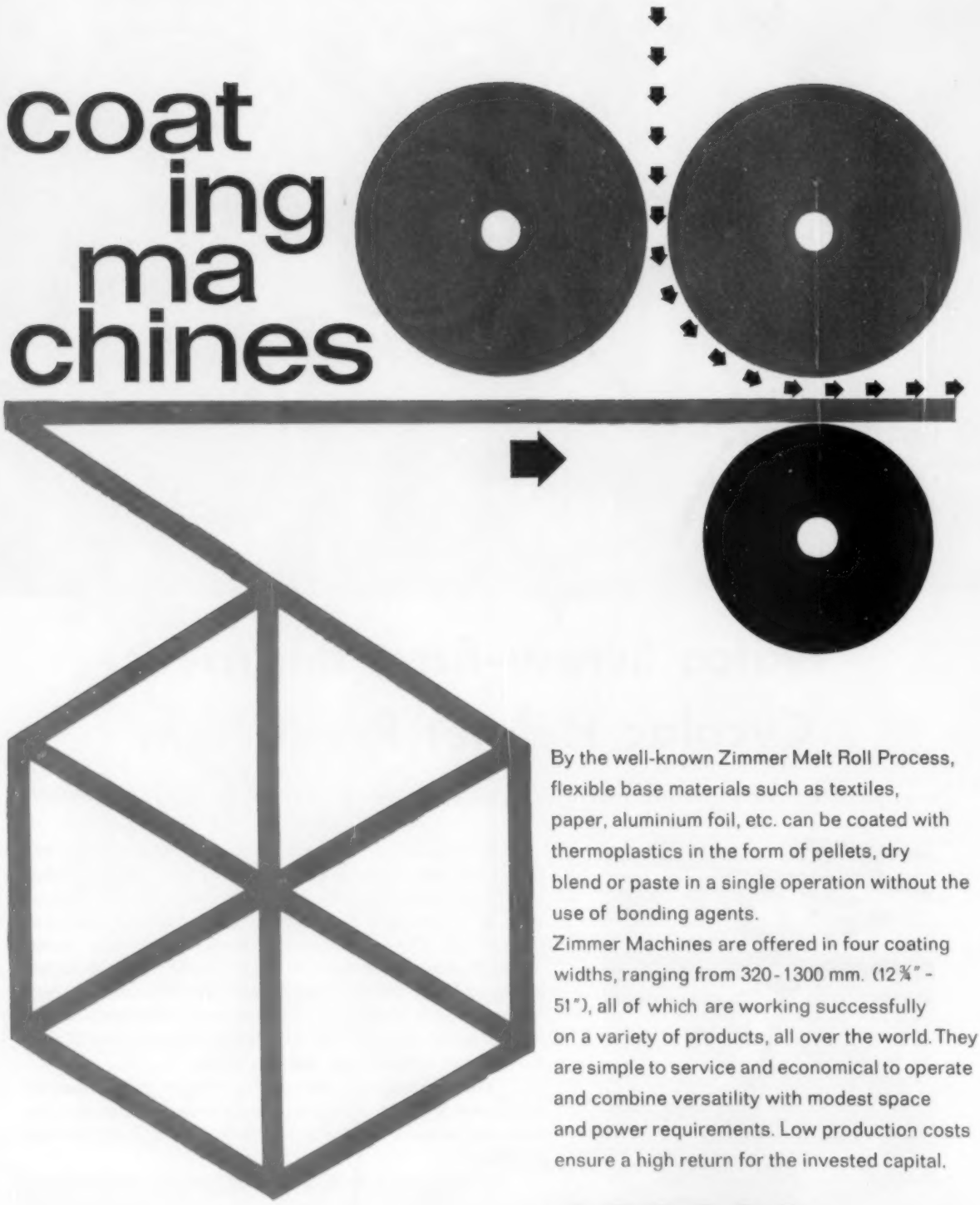
"We are convinced that this new Natco screw injection machine is an ideal production tool for our custom molding work and we have a new 650 ton Natco Screw-Ram machine on order."

Investigate what these new Natco extruder-injection machines will do for you. Stock machine sizes from 35 to 140 ounces. Write today for complete specifications.

NATCO
SCREW-RAM

NATIONAL AUTOMATIC TOOL COMPANY, INC.
PLASTICS MACHINERY DIVISION
RICHMOND, INDIANA, U. S. A.

coat ing ma chines



By the well-known Zimmer Melt Roll Process, flexible base materials such as textiles, paper, aluminium foil, etc. can be coated with thermoplastics in the form of pellets, dry blend or paste in a single operation without the use of bonding agents.
Zimmer Machines are offered in four coating widths, ranging from 320-1300 mm. (12¾" - 51"), all of which are working successfully on a variety of products, all over the world. They are simple to service and economical to operate and combine versatility with modest space and power requirements. Low production costs ensure a high return for the invested capital.

ZIMMER

ZIMMER PLASTIC GMBH

74, Frankfurter Strasse · Offenbach am Main · Western-Germany

Gering Quality Molding Compounds Answer Your Demands...

• for the fullest color range with uniformity from batch to batch • for exact physical properties that improve production by fewer rejects and faster molding cycles • for money-saving, quality-formulated *polyethylene, polypropylene, vinyl, polystyrene, styrene copolymers, acetate, nylon, acrylic and butyrate.*

GERING

PLASTICS

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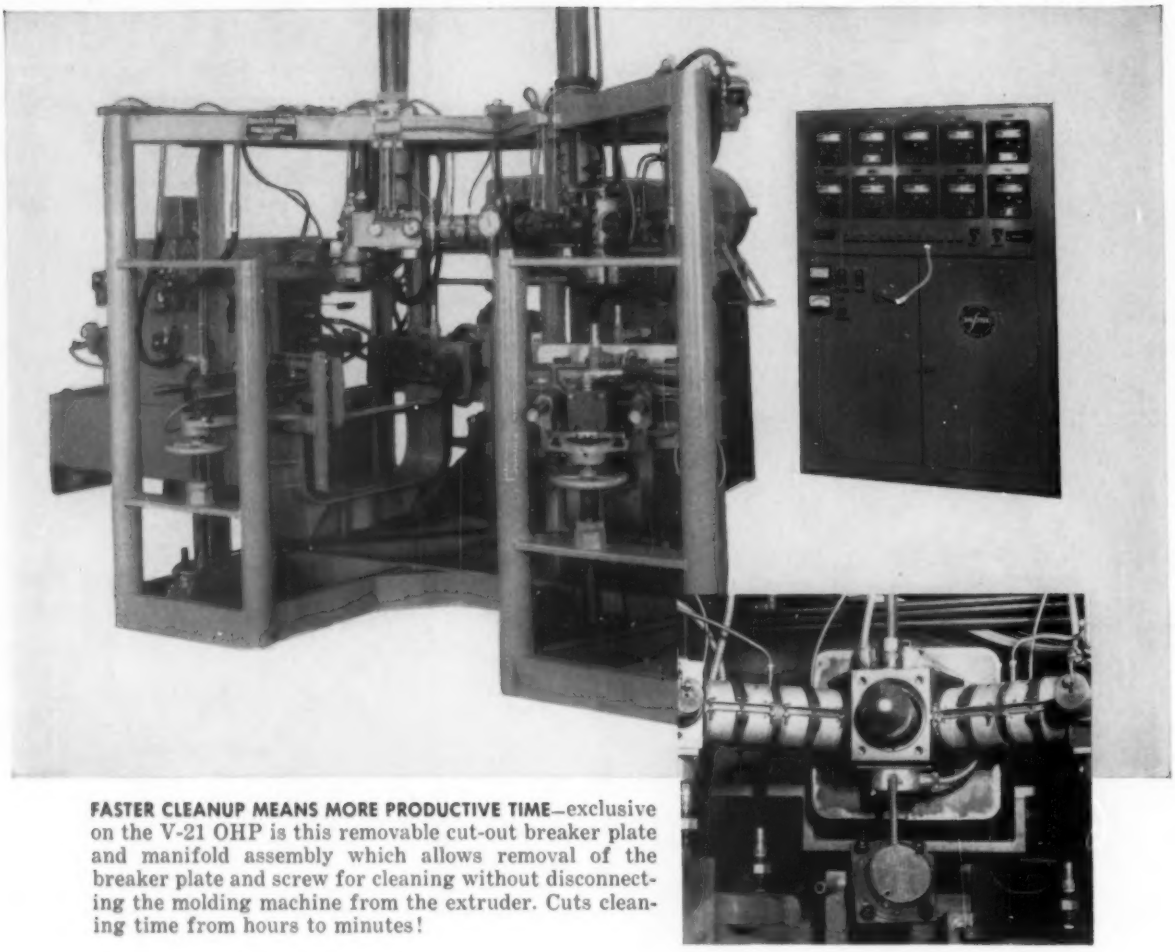


FASTER CLEANUP MEANS MORE PRODUCTIVE TIME—exclusive on the V-21 OHP is this removable cut-out breaker plate and manifold assembly which allows removal of the breaker plate and screw for cleaning without disconnecting the molding machine from the extruder. Cuts cleaning time from hours to minutes!

FOR BLOW MOLDING, MPM'S MADE THE TWO STATION

V-21 OHP Diversamatic faster more versatile than ever!

WITH FULL HYDRAULIC OPERATION AND SEPARATE X-ALOY-LINED ACCUMULATOR FOR EACH STATION

HIGH SPEED FOR HIGH PERFORMANCE— Diversamatic's unique twin-station design almost doubles your production. As one station is cooling the other is extruding and forming, giving you continuous, uninterrupted operation. And, Diversamatic with multiple heads on each station has been production run at speeds up to 1,500 one-quart bottles per hour.

VERSATILITY FOR HIGH PERFORMANCE—Either identical or different molds can be run at the same time, making it possible for you to produce a *different* item on each of the two stations. You can use up to *four* heads on each station for even greater versatility—greater speed. Separate accumulators on each station assure you of highly accurate parison delivery.

EASY OPERATION CUTS YOUR COSTS—Diversamatic is fully automatic, being controlled electronically by a nearby console. The machine also has manual controls for fast mold set-up and test runs. It requires minimum operator supervision, and is so simple to run that it is being operated by persons having no previous experience or knowledge in the plastics field.

MPM's COMPLETE MANUFACTURING FACILITIES— no mere assembler, MPM manufactures all its components, then pilot tests the completed unit. When you choose MPM, you can arrange to see your equipment in operation before it is shipped.

Write today for full information on MPM blow molding equipment. Manufactured under U.S. Patent 2980955. Other patents pending.

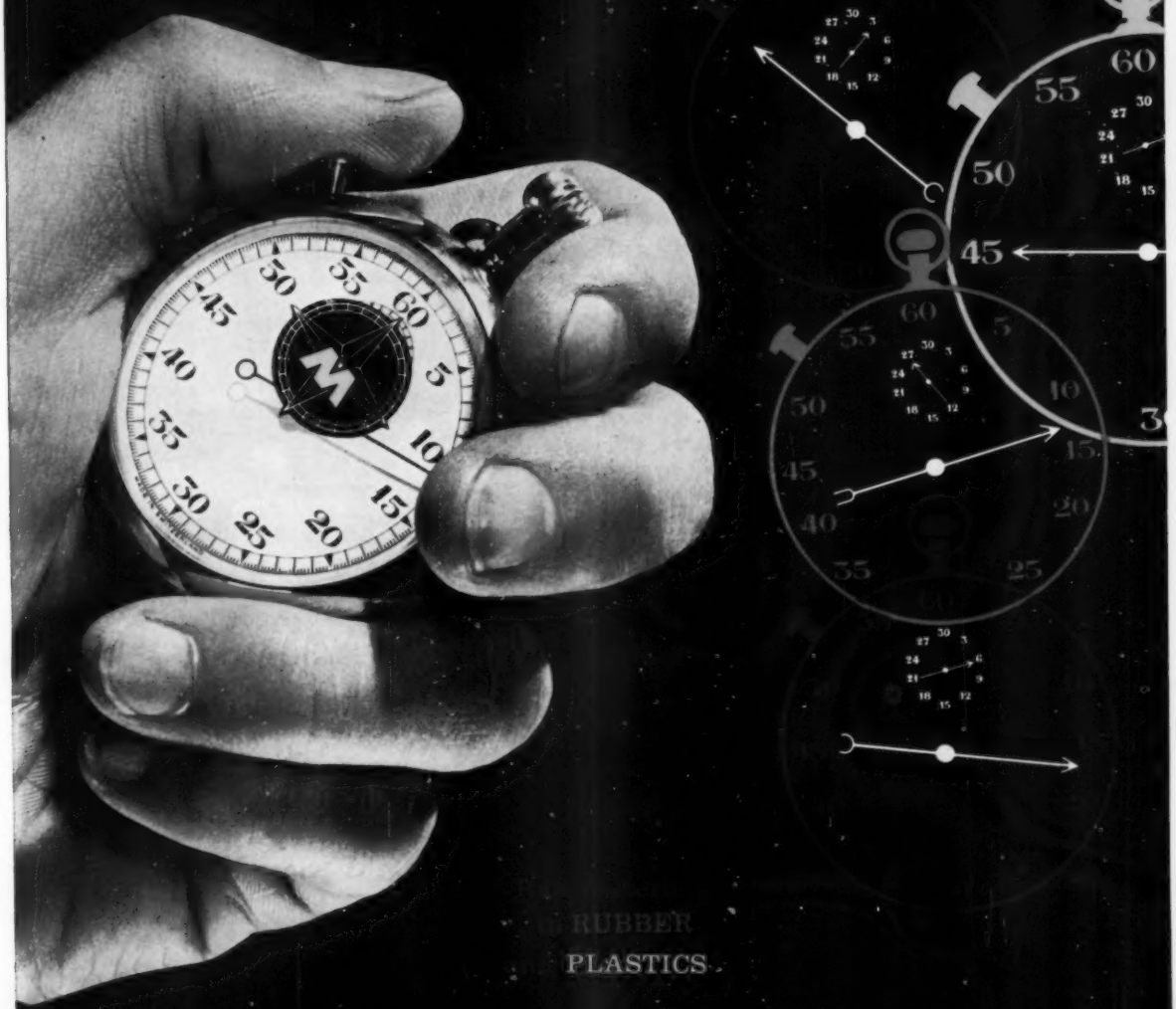
Modern Plastic Machinery Corp.

General offices and engineering laboratories: 64 Lakeview Avenue, Clifton, N. J.

when you need

swift service . . .

MUEHLSTEIN



RUBBER

PLASTICS

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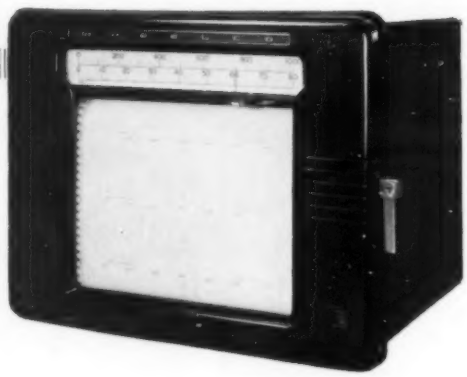
Pressure-temperature operation is here!

Research by Barber-Colman and cooperating members of the Plastics Industry has proved the practicality of pressure-temperature operation. Pressure indication speeds return to best mixing conditions and gives faster read-out of screw or screen troubles. Savings up to 1/3 have been reported by users. The new instruments below are specifically designed to aid plastics production. Ask your Barber-Colman Sales and Service Engineer today.



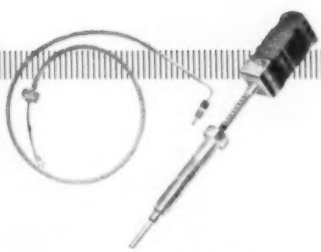
Record any combination of pressure and temperature up to 24 points

The new Series 8000 Multipoint Recorders are electronic potentiometer instruments with zero and span adjustment for the pressure range. Dual 11″ scales indicate temperature and pressure. Accuracy is ±¼ of 1% in typical ranges between 0-800°F and 0-10,000 psig. Zener diode constant voltage source. Up to six high or low limit switches. Swing-away chassis. Series 2000 Round Chart Recorders are available for r.p.m. or foot-per-minute control of plastic sheet roll units.

Now you can indicate temperature or pressure on only one instrument while controlling temperature. Simply flip the selector switch. The new Series 400 Capacitrol Indicators offer 6″ direct reading scale, and high or low limits.

Series 400 Capacitrols indicate and control temperatures. Available with Truline "anticipatory" time proportioning. Accurate 6″ scale . . . famed no-contact "Electronic Link"...plug-in chassis. Sensitive, accurate and reliable.

Specially designed for the plastics industry, Model 297 Capacitrols offer accurate "Electronic Link" and built-in anticipating control. Easy-to-read 5″ scale, plug-in components, compact size. Sensitive, dependable and economical.



Barber-Colman offers a complete line of sensing devices and control accessories . . . thermocouples, pressure transducers, radiation detectors, resistance bulbs and pyrometers. Make Barber-Colman your control headquarters today.

BARBER COLMAN

BARBER-COLMAN COMPANY

Wheelco Industrial Instruments Division

Dept. T, 1517 Rock Street, Rockford, Illinois, U.S.A.

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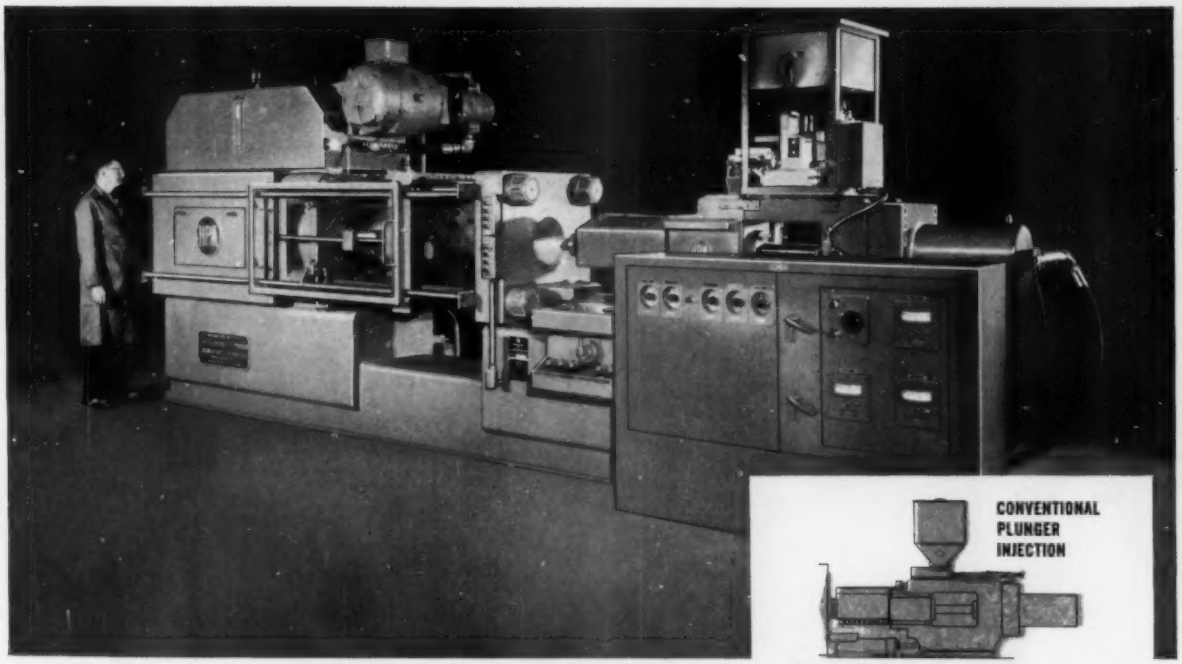


This is an H-P-M 350 ton machine with a material capacity of 12/16 oz. per cycle (Model 350-HV-12/16). It is equipped with a 30 HP booster power unit to increase injection rate. The smaller H-P-M 200 ton clamp machine is similar to this machine in appearance.

What do YOU need?

in 200 and 350 ton Injection Machines

With these two popular H-P-M injection molding machines, in the 6 oz. to 28 oz. range, you can get just what *you* need "custom-built" from a broad selection of standard elements. Check at the right the different injection combinations available with 200 or 350 ton clamps, and each available with optional booster power units for increased injection rates. They're fast, dependable and easily maintained. Unit construction of standard H-P-M machines permits almost unlimited variety of machine design at great savings. Contact us, today, for complete information.

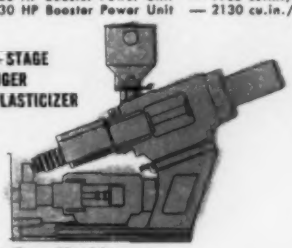
H103

CONVENTIONAL PLUNGER INJECTION

200 Ton Machine —
6/8 oz. Capacity — 675 cu.in./min.
with 20 HP Booster Power Unit — 1350 cu.in./min.

350 Ton Machine —
12/16 oz. Capacity — 1230 cu.in./min.
with 20 HP Booster Power Unit — 1905 cu.in./min.
with 30 HP Booster Power Unit — 2130 cu.in./min.

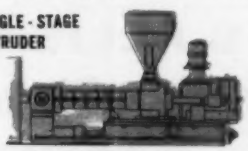
TWO-STAGE PLUNGER PREPLASTICIZER



200 Ton Machine —
28 oz. Capacity equipped with
20 HP Booster Power Unit — 1320 cu.in./min.

350 Ton Machine —
28 oz. Capacity — 1210 cu.in./min.
with 20 HP Booster Power Unit — 1885 cu.in./min.
with 30 HP Booster Power Unit — 2110 cu.in./min.

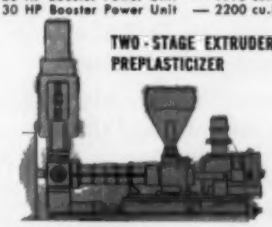
SINGLE-STAGE EXTRUDER



200 Ton Machine —
15 oz. Capacity — 690 cu.in./min.
with 20 HP Booster Power Unit — 1380 cu.in./min.

350 Ton Machine —
15 oz. Capacity — 1300 cu.in./min.
with 20 HP Booster Power Unit — 1990 cu.in./min.
with 30 HP Booster Power Unit — 2200 cu.in./min.

TWO-STAGE EXTRUDER PREPLASTICIZER



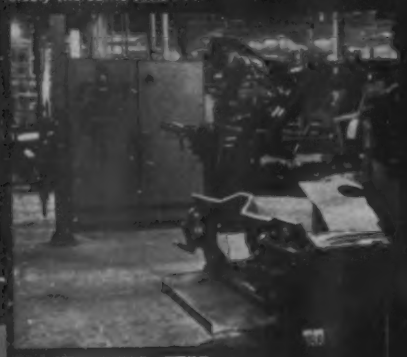
200 Ton Machine —
28 oz. Capacity — 675 cu.in./min.
with 20 HP Booster Power Unit — 1350 cu.in./min.

350 Ton Machine —
28 oz. Capacity — 1230 cu.in./min.
with 20 HP Booster Power Unit — 1905 cu.in./min.
with 30 HP Booster Power Unit — 2130 cu.in./min.

H-P-M DIVISION
Koehring Company

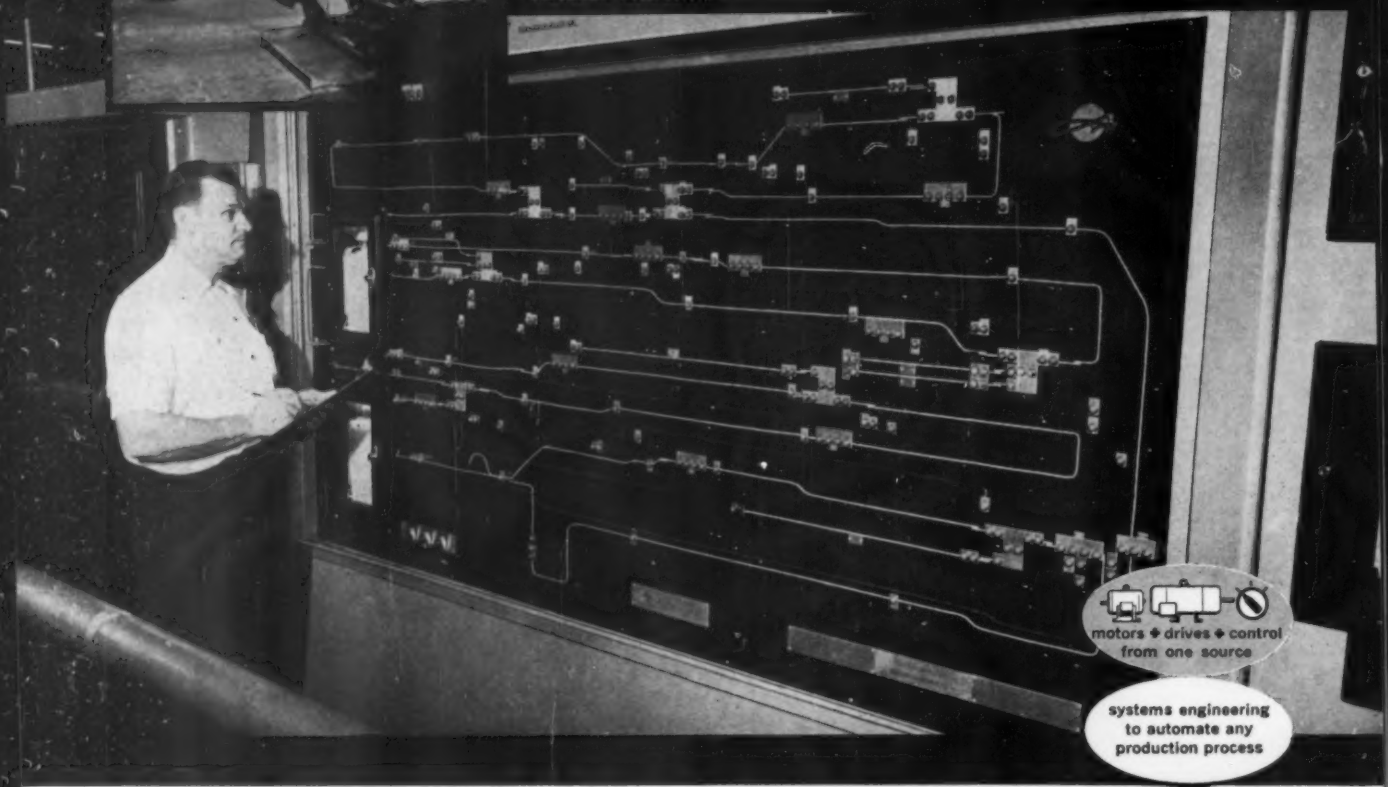
Mount Gilead, Ohio, U. S. A.

FROM INITIAL BODY ASSEMBLY—Louis Allis controllers coordinate the intricate assembly of side gate framing fixtures and underbody just prior to welding by synchronizing the arrival of three components from three different locations at precisely the same time . . .



TO PRE-FINAL ASSEMBLY AREA—where a bank of Louis Allis controllers regulate the drives powering the mating line where unitized body, stub-frame / engine assembly and running gear are assembled into units like the Plymouth convertible shown coming off the assembly line . . .

AND 3-DIMENSIONAL AREA CONTROL CENTER — which monitors conveyor operations. Any type of production interruption is quickly revealed and identified by signal light indication. Recorders provide a permanent daily record of each conveyor's operation.



motors ✦ drives ✦ control from one source

systems engineering to automate any production process

LOUIS ALLIS engineered systems automate Chrysler assembly lines

An automobile assembly line is a materials handling complex of movement and synchronization. Feeder lines joining the main-line must deliver components on time — and in perfect synchronism. Still, the system must be flexible enough to accommodate speed changes when desired.

The Plymouth assembly plants in Detroit and St. Louis are models of this type of automation . . . and electrical components for the materials handling systems were custom-engineered by Louis Allis. L. A. systems engineers worked with Plymouth engineers to map the flow sequence. Louis Allis provided the adjustable speed drives and precision controls to operate the systems and supervised the installation. The result: integrated, automated systems that eliminate time loss, manpower waste, and excess materials handling costs.

Synchronized conveyors operate at pre-set speeds by following built-in master job-rate controllers. The system provides for automatic, position-perfect transfer of body components from one conveyor to another. A three-dimensional area control center monitors and records all conveyor operations.

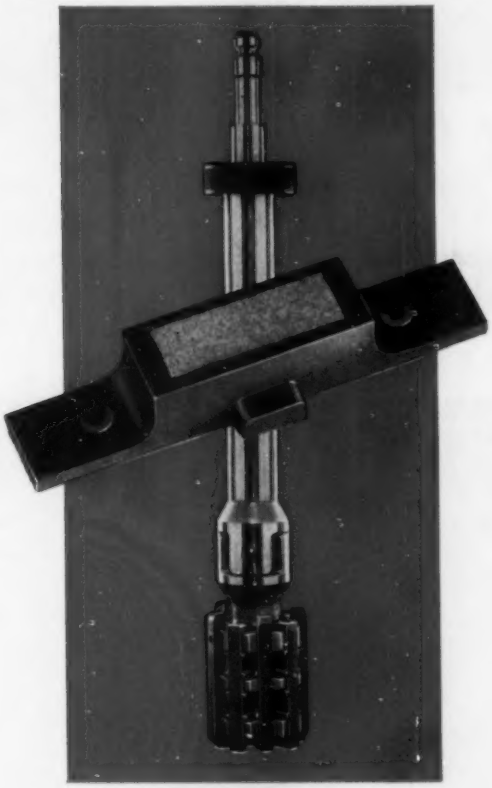
If your plans call for automation, contact Louis Allis for systems engineering assistance — and single-source responsibility of drive and control design, manufacturing, and service. Call the Louis Allis District Office nearest you, or write to The Louis Allis Co., 470 East Stewart Street, Milwaukee 1, Wisconsin. Ask for Bulletin 2900.

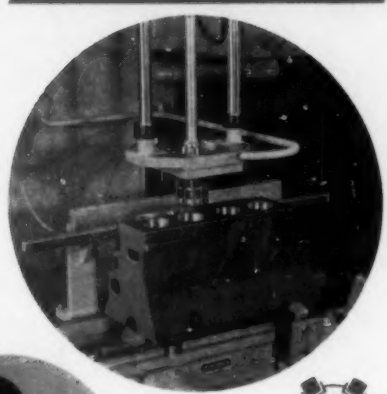
LOUIS ALLIS

ASD-230

MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

If phenolics can do it, **PLENCO** can provide it—and does—for **MICROMATIC HONE CORPORATION**





this is the holder

(MOLDED WITH PHENOLICS)

that grips the "stone"

(THE ABRASIVE CUTTING-SURFACE)

that puts the hone

(THE ULTRA-PRECISION TOOL)

in Micromatic Microhoning

(THE CONTROLLED ABRADING PROCESS)

Into the hardest of case-hardened steels bite the abrasive cutting-surfaces used in the modern *Microhoning* process of controlled abrading. Into soft plastics, too, brittle ceramics, even glass. Control is so positive, technique so perfected, and results so precise that geometric tolerances to within .0001 of an inch are obtainable.

Developed by Micromatic Hone Corporation, Detroit, Mich., Microhoning provides one of the most efficient methods devised for the removal of stock from both internal and external cylindrical surfaces.

One key to this high precision automatic honing process is the abrasive stone in its molded holder. When *Plenco* phenolics are specified as the molding material they are chosen on the basis of the compound's adaptability to a wide range of abrasive grades, and—most importantly—its uniform flow and *uniform shrinkage*. Such assured dimensional stability is essential. Because the holder must fit and hold the abrasive securely and precisely. In addition, any deformation in the molded casing must be minimal and predictable, since its outer perimeter is used in some Microhoning cycles as a gage to maintain correct size of the work.

In countless, varied applications, *ready-made or custom-formulated* Plenco phenolic molding compounds have met the critical demands of industry. If you've a molding problem you want to avoid "rubbing the wrong way", feel free to consult with our broadly experienced technical staff.

PLENCO PHENOLICS
FOR BETTER PLASTIC PRODUCTS

MICRO MATIC

PLENCO

PHENOLIC MOLDING COMPOUNDS

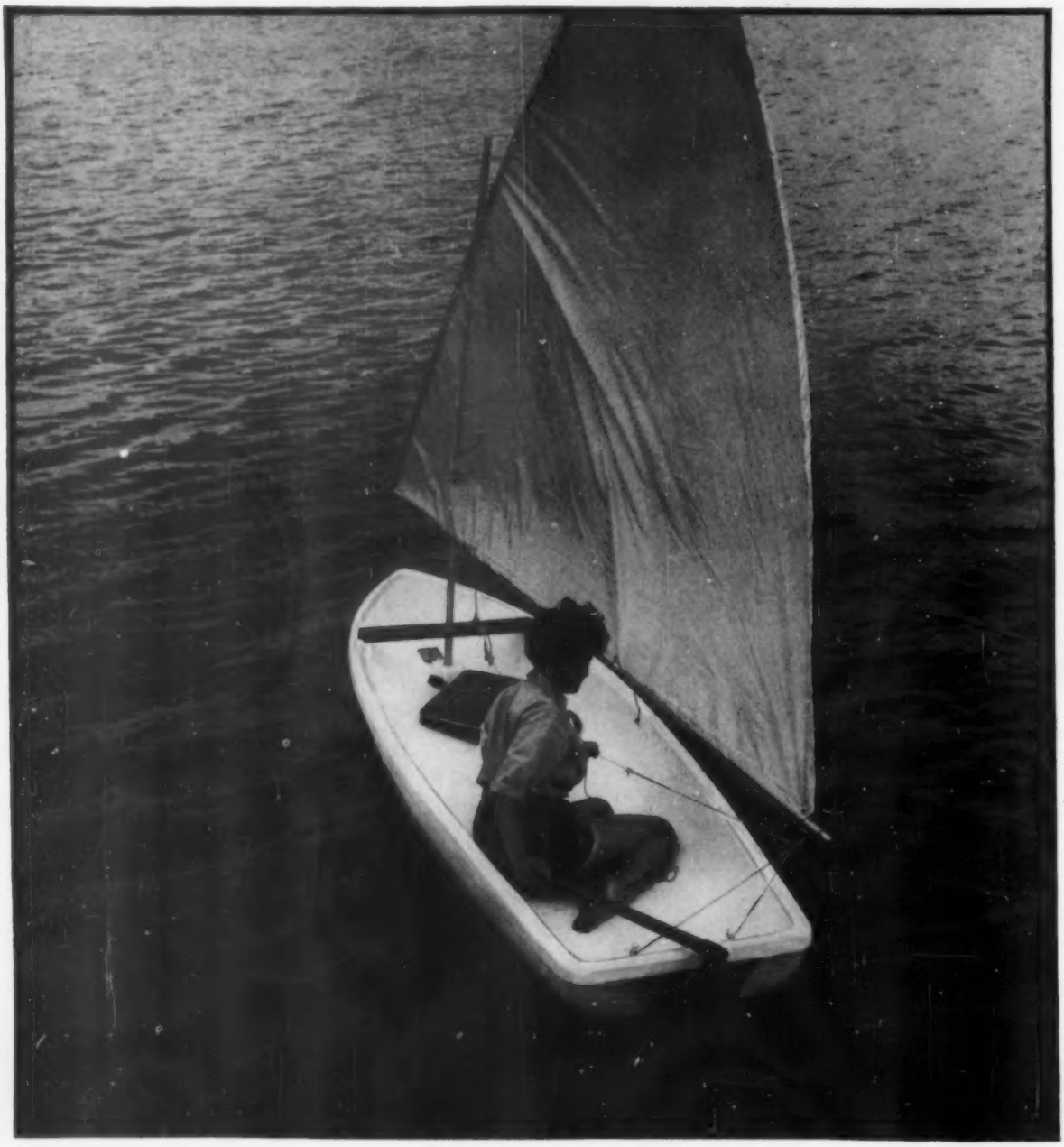
PLASTICS ENGINEERING COMPANY

Sheboygan, Wisconsin

Serving the plastics industry in the manufacture of high grade phenolic molding compounds, industrial resins and coating resins.

Foam plastic makes this boat unsinkable

The hull of this 11 ft. sailboat, designed to sell for under $100, is one solid piece of foam plastic—DYLITE® expandable polystyrene. Because of its tight cell structure and light weight, this amazing material has unmatched buoyancy. The boat stays afloat even if it's completely flooded. It can't become waterlogged because DYLITE doesn't absorb water. The hull weighs only 30 pounds, yet it can support over 500 pounds. Another Koppers plastic, DURETHENE® polyethylene film, is used in the durable yellow sail. Boat manufactured by Snark Products, Inc., Fort Lee, New Jersey.



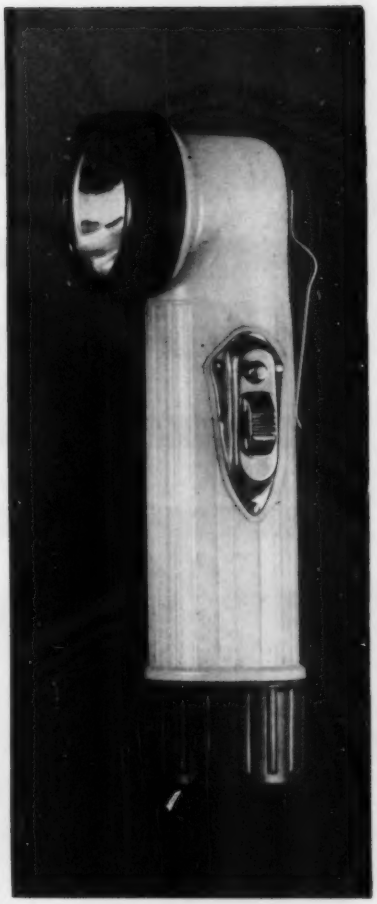
Cooler liner formed without thin spots

The interior liner of this Hamilton-Skotch picnic chest is thermo-formed from SUPER DYLAN® high-density polyethylene. This impact-resistant plastic is used because it's the only polyethylene that can be formed into this difficult deep-draw piece without producing thin spots or mold marks. The seamless liner won't leak, absorb food odors or water. Its smooth, white finish can't stain, discolor, rust or corrode—it's easy to keep clean. Bottles, cans and chunks of ice won't mar or crack its tough surface. Cooler Chest Manufactured by The Hamilton-Skotch Corporation, New York 16, New York.

Foam trays simplify toy packaging

A. C. Gilbert Company uses DYLITE expandable polystyrene trays because they completely eliminate costly interior packing materials. DYLITE trays are strong, good looking, easy to assemble and load—they save on labor costs. They also cut shipping costs because they're extremely lightweight.

DYLITE packages come in any size or shape; they fit firmly around the product and protect it from shipping damage. They make an attractive display because their smooth, colorful surface won't smear, chip or flake. DYLITE parts molded by Sullifoam Products, Willow Grove, Pennsylvania.



Flashlight guaranteed not to break

This new right-angle flashlight case is guaranteed unbreakable because it's molded from strong DYLAN® polyethylene. It's colorful, can't chip or flake. Unlike metal flashlights, it won't rust or corrode and it's completely acid-proof.

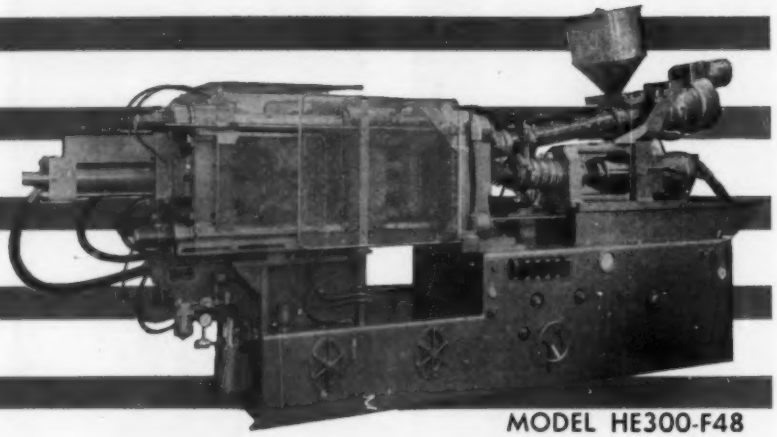
Koppers has a wide range of polyethylenes available for almost any application. They come in densities from .914 to .953 gm./ml. By varying density, molders or design engineers can get varying degrees of stiffness, heat distortion and tensile strength. Remember too, that polyethylenes can give you a wide range of colors. Flashlight manufactured by J. P. Gits Corp., Chicago, Illinois.

KOPPERS PLASTICS

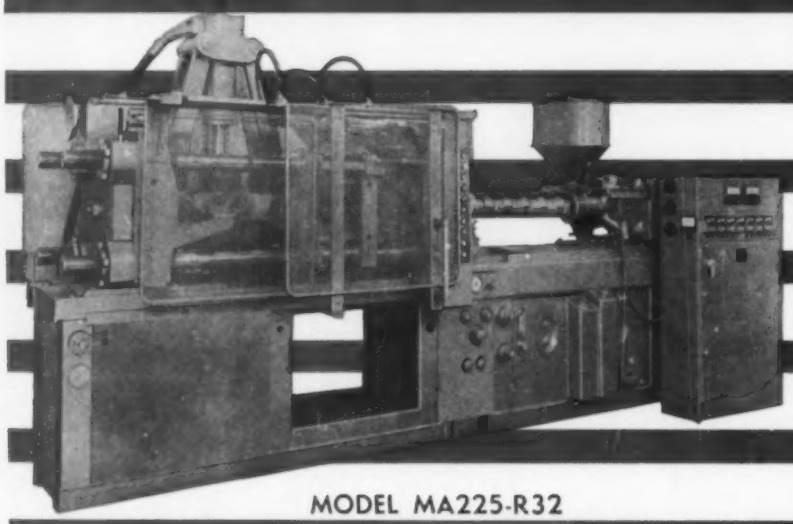
Find out how Koppers family of plastics can help improve your product at less cost. For more details write Koppers Company, Inc., Plastics Division, Dept. 135, Pittsburgh 19, Pa.

KOPPERS®

NOW— SCREW-TYPE PLASTIFYING



MODEL HE300-F48



MODEL MA225-R32

ON IMPCO INJECTION MOLDING MACHINES

To meet the needs of the plastic molding industry, Impco offers a complete line of screw plastifiers. Various design adaptions for this type of plastifying are now available on all of our machine models. Bulletins describing these adaptions as applied to Impco 175, 225, 275, 300 and 450 ton clamp models are on hand. Send for them today. We will be happy to discuss these and other significant improvements with you.

IMPCO®

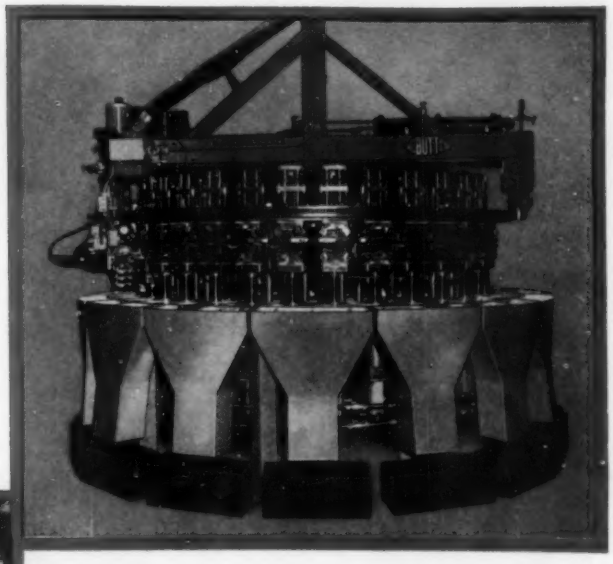
IMPROVED MACHINERY INC.

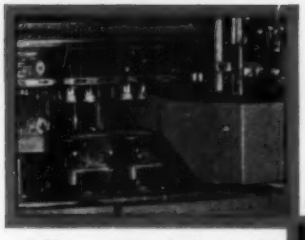
NASHUA, NEW HAMPSHIRE

IN CANADA: SHERBROOKE MACHINERIES LIMITED, SHERBROOKE, QUEBEC
IN EUROPE: SUNDS VERKSTADER AB, SUNDSBRUK, SWEDEN

6,000 PIECES PER HOUR

This **NEBUTTCO** Automatic Rotary Press Molds Thermosetting Closures FAST





Molds are progressively opened, charged with compound, and closed under pressure for curing as feeding arm revolves around machine.

Cam-actuated rotating wheel automatically unscrews closures as molding cycle is completed.

The thirty stations on this Nebuttco Rotary Press provide high speed, continuous molding of large or small quantities using any free-flowing thermosetting compound in low cost, single or double cavity molds. Providing the closures are the same color and similar in section, as many as three different molds can be used in the machine at one time.

The compound is hopper-fed, and precision metered through the rotating feeder arm. Machine eliminates sorting problems, because stations eject parts into separate metal chutes. Production cycle can be varied and the temperature in the mold holders can be individually adjusted if required.

The machine is available in one model — the thirty-station press illustrated. This machine is easy to install and maintain, and is adaptable for many applications.

For more information please contact

NEW ENGLAND BUTT COMPANY
Division of Wanskuck Co.
304 Pearl Street, Providence 7, Rhode Island

TRAFFIC MANAGER – This phenolic laminate strip being inserted in a letter tray in New York's General Post Office plays a vital role in routing mail along a conveyorized "mail flow" system. Adopted by the Post Office in many principal cities, mail flow systems have elevated efficiency by relieving postal employees of the need to hand-carry mail between sorting stations. The New York Post Office now handles approximately 34 million pieces of mail every 24 hours! And during the four-hour peak traffic period of the average day, letter trays make an average of 10,000 trips over the conveyors linking the primary sorting stations with secondary sorting stations. Called "signal cards," these phenolic laminate strips have windows cut into the face of each card which exposes a stainless steel center ply in a pattern keyed to one of the secondary stations. When the tray arrives at the proper station, the signal card key-pattern electrically actuates a mechanism that diverts the tray from the conveyor to its proper destination. Laminated phenolic was specified for the signal cards because of its durability, light weight, and positive electrical insulation. These cards were produced by Taylor Fibre Company, Norristown, Pa., and made with Mount Vernon duck.

This is another example of how fabrics made by Mount Vernon Mills, Inc. and the industries they serve, are serving America. Mount Vernon engineers and its laboratory facilities are available to help you in the development of any new fabric or in the application of those already available.

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we'll make the press

YOU NAME THE MATERIAL CHARACTERISTICS

Just tell us the nature of the material—polyester, acrylic, fiber glass, rubber, or whatever—and give us your production specifications. We'll build the right compression molding press to meet your needs.

Erie Foundry regularly builds hydraulic molding presses in capacities of 25 to 4,000 tons. Our advanced design control systems will apply forces accurately and precisely, maintain platen temperatures within close tolerances, and perform molding cycles with split-second timing. Versatility is built in so that a wide range of molding jobs can be handled.

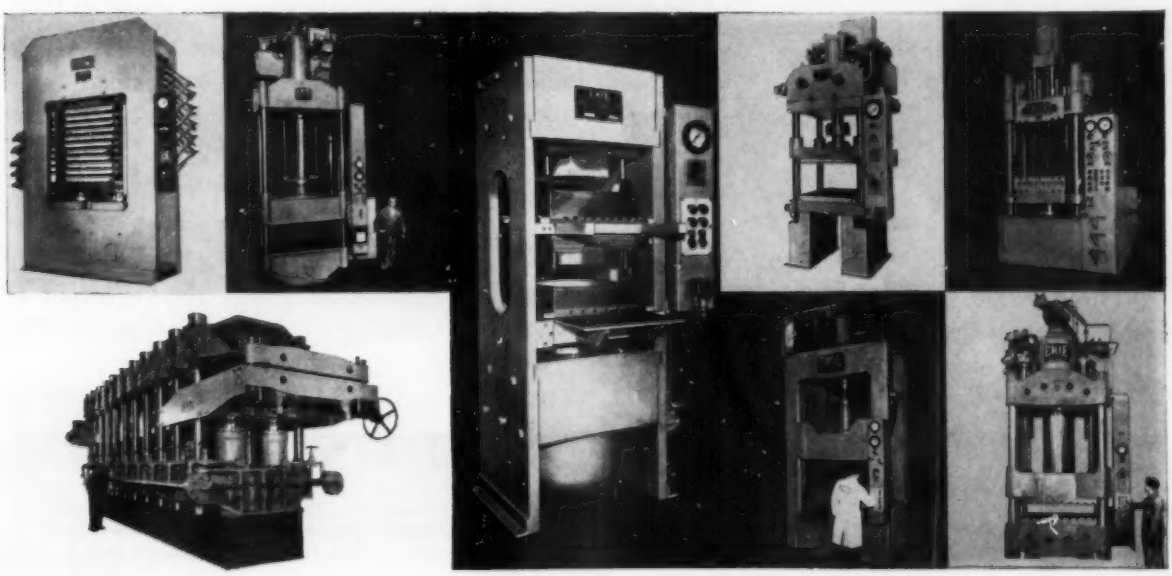
Write now for your copies of our descriptive bulletins on Erie Foundry hydraulic presses for rubber and plastics.

Hydraulic Press Division

ERIE FOUNDRY CO. ERIE, PA.

ERIE

THE GREATEST NAME IN FORGING . . . SINCE 1895



which of these quality PPG fiber glass reinforcements fits your operations?

533 Roving . . . for filament winding, panels, rod stock

. . . highly effective wet-out with polyesters, phenolics and epoxies in producing translucent products with high unidirectional strength.

520 Roving . . . for spray-up applications

. . . provides close control in uniformity, cuts clean, dispenses freely, wets well, has color trace strand.

508 Roving . . . for preform molding

. . . drapes well, distributes evenly, conforms well, runs free of static, has high strength, cuts rejects to a minimum.

Chopped Strand Mat . . . for sheets, boats, high pressure molding

. . . wets out faster than ordinary mat, has uniform fiber distribution; provides improved strength, appearance and workability; pure whiteness eliminates discoloration.

TECHNICAL HELP AVAILABLE

Samples of these quality reinforcements are available for trials in your own plant. A PPG technical staff man will be glad to answer any questions you may have and demonstrate techniques and machinery adjustments to get best production results.

For literature and other information, get in touch with your nearest PPG Fiber Glass Sales Office or regional distributor, or write *Pittsburgh Plate Glass Company, Fiber Glass Division, One Gateway Center, Pittsburgh 22, Pa.*

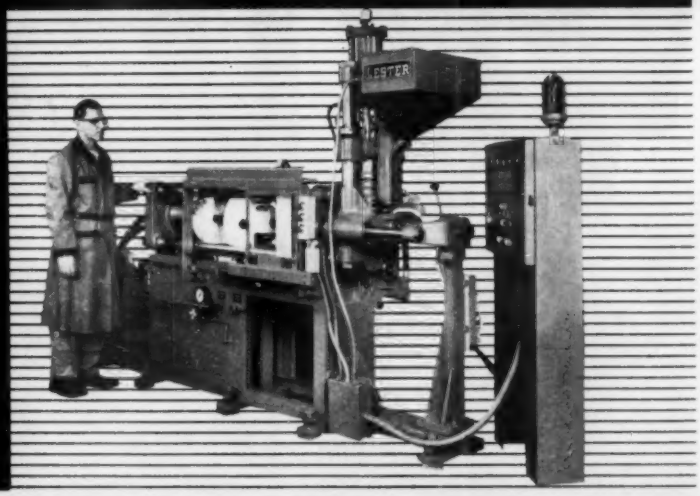
FIBER PPG GLASS PITTSBURGH PLATE GLASS COMPANY

Sales Offices: Atlanta, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Dallas, Detroit, Houston, Kansas City, Louisville, Los Angeles, Miami, Milwaukee, Minneapolis, New Orleans, New York, Philadelphia, Pittsburgh, San Francisco, St. Louis and Seattle

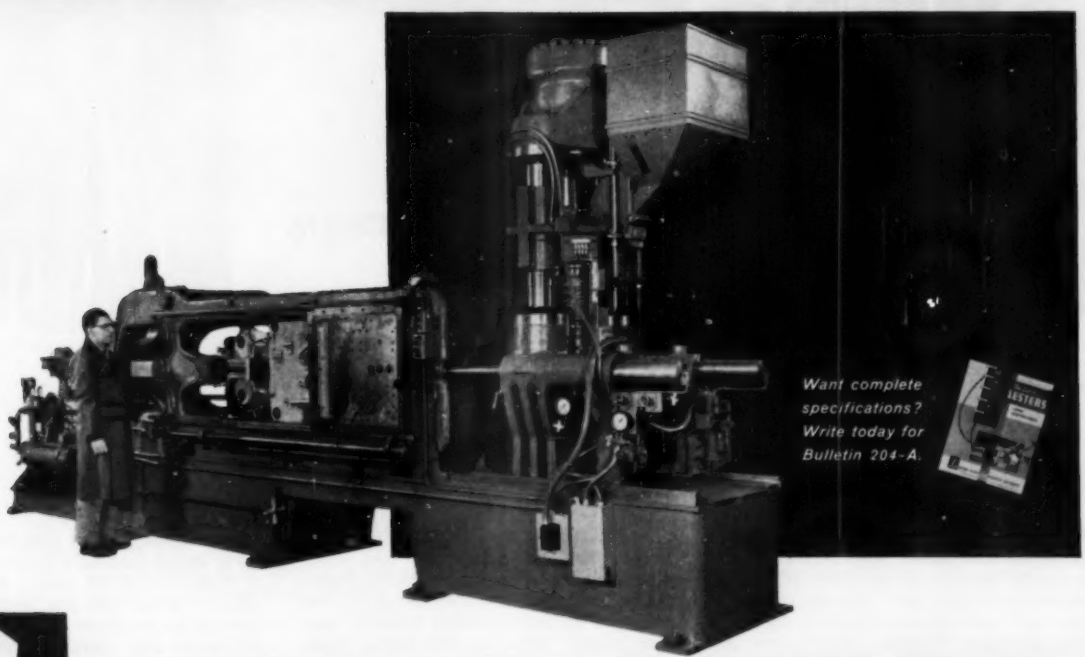
when you consider new
INJECTION MOLDING MACHINES...

from 2 to 32 ounces

...be sure to check the advantages of LESTERS. The unique features of all standard machines (plus 14 optional auxiliary circuits for special jobs) give a flexibility of use that is unequaled in the field.



LESTER



Want complete specifications? Write today for Bulletin 204-A.

LESTER INJECTION MOLDING MACHINES

Distributed by **Lester-Phoenix, Inc. • 2621L Church Avenue • Cleveland 13, Ohio**

Agents in principal cities throughout the world

8 out of 10 distributor caps in the U.S.A. are made of G-E Phenolics!

Example: this Autolite 6-cylinder cap for Chrysler. Why does Electric Autolite specify G-E 12944 Phenolic Molding Compound? Because it offers the best possible combination of performance and molding characteristics for Autolite's line of distributor caps:

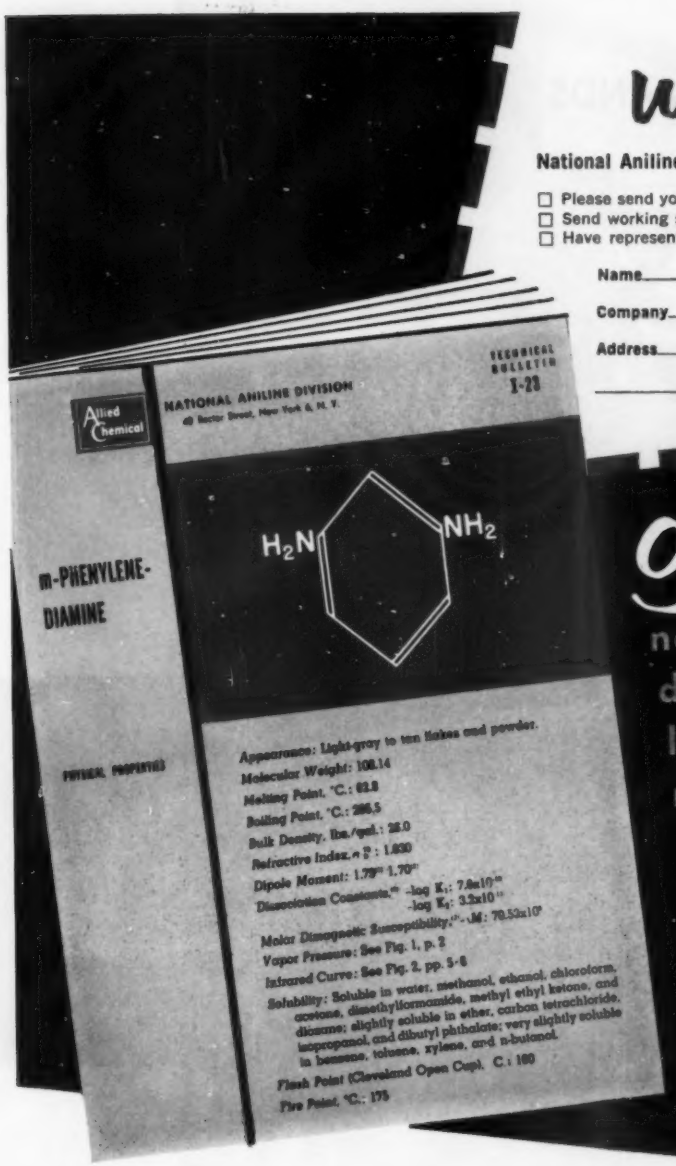
1. Performance—Physical properties of the G-E 12944 parts include dimensional stability, resistance to carbonization (tracking), and ability to stand up under extremes of cold and heat (–40F to 250F). The phenolic has good electrical properties and is able to take rough handling, vibration and shock.

2. Molding Characteristics—G-E 12944 phenolic compound has good plasticity. Its special flow characteristics allow the resin to surround the multiple metallic inserts quickly and completely without disturbing their position and to fill the intricate distributor cap mold rapidly. G-E 12944 cures quickly. It permits short molding cycles — a necessity for this mass-production part.

General Electric has tailored this compound specifically for automotive use. It is an example of the care and effort we expend in formulating a compound to meet individual engineering and manufacturing requirements. We have many standard phenolics to meet a wide variety of needs, but we'll be glad to work with you in developing a special formulation to meet *your* specifications. For more information write to: General Electric Company, Section MP-461, Chemical Materials Department, Pittsfield, Mass.

Phenolics-first of the modern plastics...first in value

GENERAL ELECTRIC


TECHNICAL BULLETIN
I-23
NATIONAL ANILINE DIVISION
40 Rector Street, New York 6, N. Y.
Allied Chemical
m-PHENYLENE-DIAMINE
PHYSICAL PROPERTIES
H_2N
NH_2
Appearance: Light-gray to tan flakes and powder.
Molecular Weight: 108.14
Melting Point, °C.: 62.8
Boiling Point, °C.: 286.5
Bulk Density, lbs./gal.: 25.0
Refractive Index, n_D^{20}: 1.630
Dipole Moment: 1.79° 1.70°
Dissociation Constants,** -log K_1: 7.8x10^-10
-log K_2: 3.2x10^-13
Molar Diamagnetic Susceptibility,** -M: 70.53x10^6
Vapor Pressure: See Fig. 1, p. 2
Infrared Curve: See Fig. 2, pp. 5-8
Solubility: Soluble in water, methanol, ethanol, chloroform, acetone, dimethylformamide, methyl ethyl ketone, and dioxane; slightly soluble in ether, carbon tetrachloride, isopropanol, and dibutyl phthalate; very slightly soluble in benzene, toluene, xylene, and n-butanol.
Flash Point (Cleveland Open Cup), C.: 180
Fire Point, °C.: 175

mail this

National Aniline Division Allied Chemical Corp., 40 Rector St., N. Y. 6

- ☐ Please send your new 36-page Technical Bulletin I-23 on m-Phenylenediamine
- ☐ Send working sample
- ☐ Have representative call by appointment

C-5

Name_____

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versatile, reactive new-product precursor

Never before m-PHENYLENEDIAMINE as pure, as stable and as light-colored as our current production.

And never before as comprehensive data on the properties, reactions and myriad potential uses of this reactive organic intermediate.

You'll find our present production to be considerably lighter in color (grey to creamy-white flakes) with strength 99.3% minimum, setting point 62.6°C, minimum solubility in HCL 99.9% and **no ammoniacal odor.** Our new high quality standard makes National m-PHENYLENEDIAMINE an intriguing intermediate or starting material for many profitable new products.

USE THE COUPON ABOVE

To help sincere researchers, we offer an exhaustive technical Bulletin on m-PHENYLENEDIAMINE. It includes complete properties plus page after page of reactions and suggested uses, all keyed to a 278-reference bibliography.

It contains a wealth of inspiration for researchers working with curing agents, ion exchange resins, decolorizing resins, formaldehyde condensates, resinous polyamides, block polymers, textile fibers, urethanes, petroleum additives, rubber chemicals, corrosion inhibitors, etc., etc. The coupon above is for your convenience.

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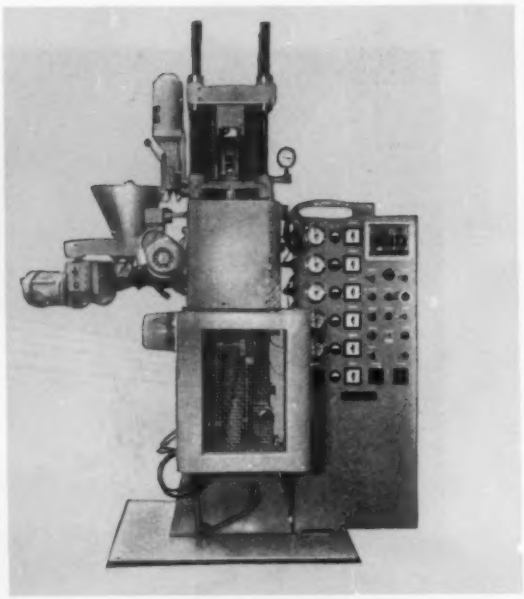
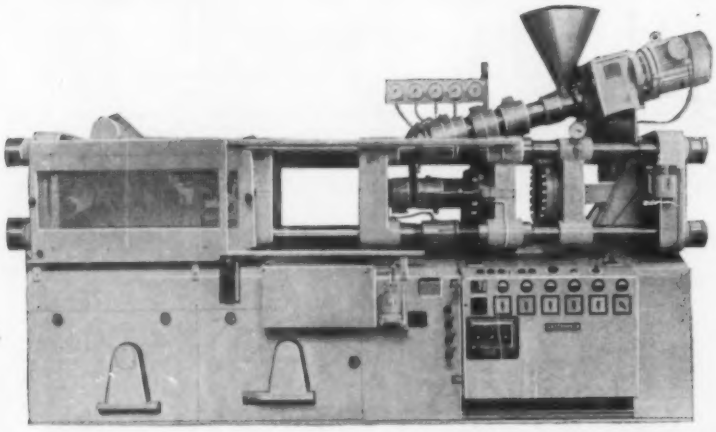
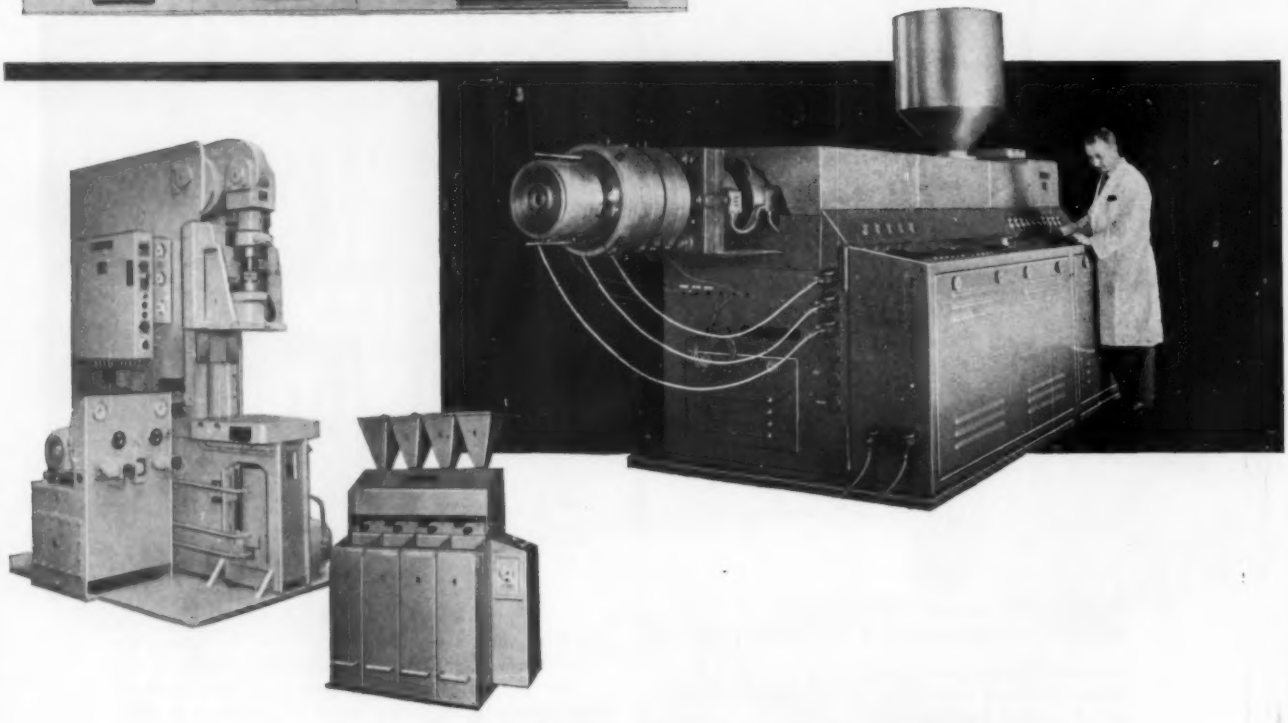
A PROGRAM FOR ALL DEMANDS





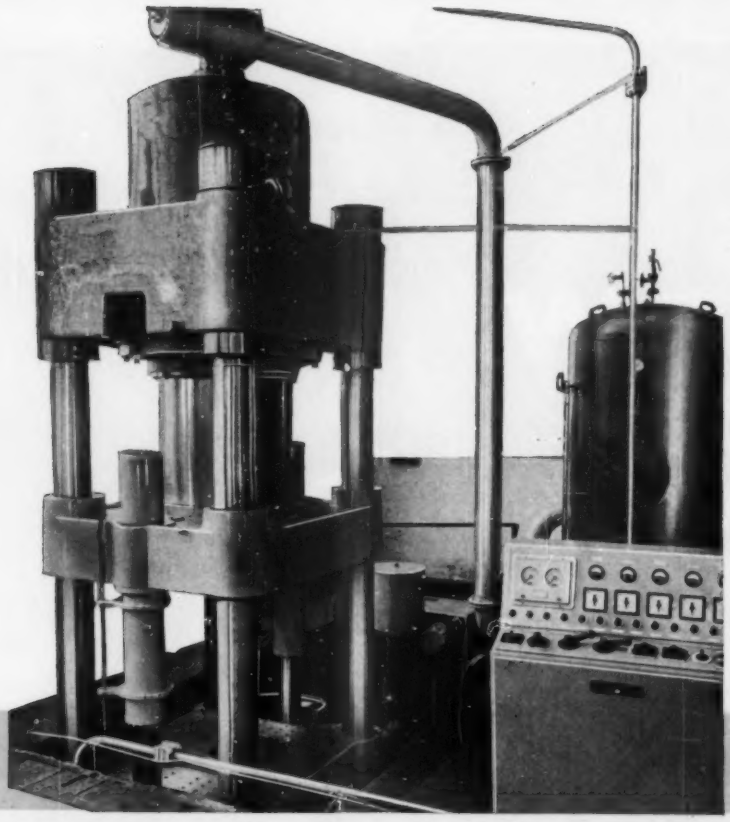


The progressive application of plastics in industry and trade requires efficient processing machines. Battenfeld automatic machines meet these requirements and impress by reliability and economical production. We are pleased to inform you of our manufacturing program and to assist you in solving all your production problems.

Main Office and Plant

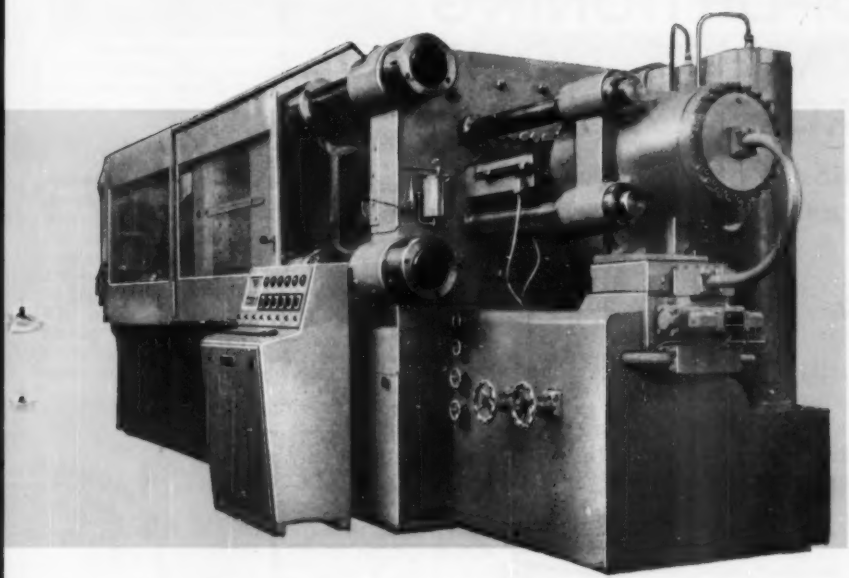
BATTENFELD MASCHINENFABRIKEN GMBH

Meinerzhagen/Westf., GERMANY



BATTENFELD

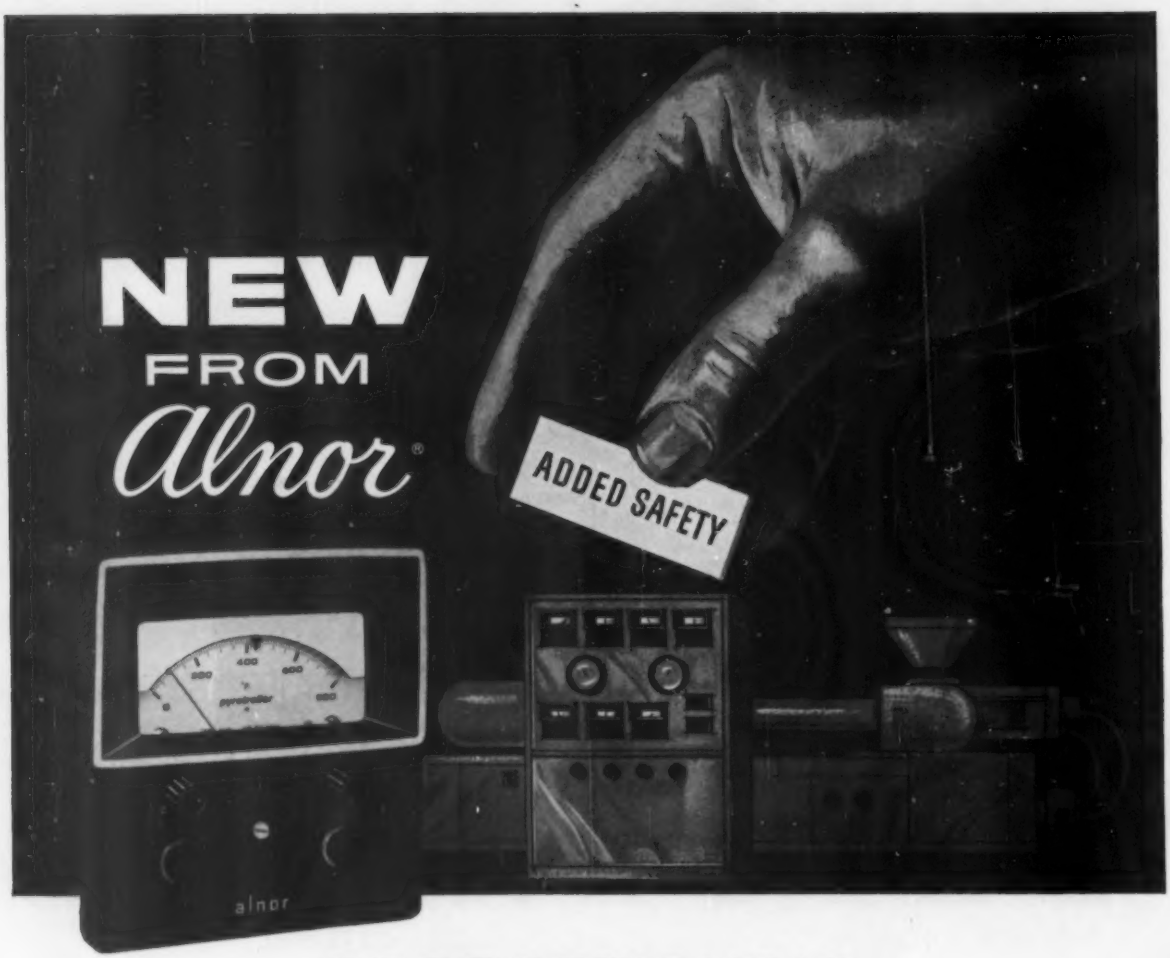
MACHINES FOR PROCESSING OF ALL PLASTIC MATERIAL



More than 7000 Battenfeld automatic injection molding machines are in operation in 67 countries all over the world. This figure evidences the confidence in our machines and is a proof for the capacity of our production plants.

We build machines handling work pieces with a weight up to 25 kgs. for the still increasing needs of injection molding equipment with large sizes.

BATTENFELD CORPORATION OF AMERICA
959 W. Grace Street, CHICAGO 13, Ill.
with Sales and Service-Organisations in
ENGLAND: Battenfeld (England) Ltd., Great South West Road, Bedfont, Feltham, Middx.



PROPORTIONING TEMPERATURE CONTROL with ADDED SAFETY

For Injection Molding, Blow Molding, Extruders and Heat Sealing Machines

HERE'S WHAT IT DOES—

1. Prevents starting of machine before plastic reaches correct molding temperature.
2. Will automatically shut-down machine if any heating element fails and the plastic drops below molding temperature.
3. The Alnor time proportioning control system accurately proportions the heat supply, thus maintaining the optimum temperature at all times.
4. Plug-in terminal features available.
5. The extremely rugged construction of the Alnor Controller makes it highly resistant to machine vibration and puts it in a class by itself for reliability.

PYROCON

Alnor—leader in temperature indicating instruments since 1919.

Alnor INSTRUMENTS

ALNOR INSTRUMENT CO.

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U.S.I. POLYETHYLENE NEWS

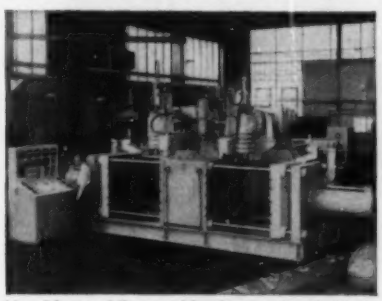
A series of advertisements for plastics and packaging executives by the makers of PETROTHENE® polyethylene resins

AUGUST, 1961 — U. S. Industrial Chemicals Co., Division of National Distillers and Chemical Corporation — 99 Park Ave., N. Y. 16, N. Y.

Packaging Notes

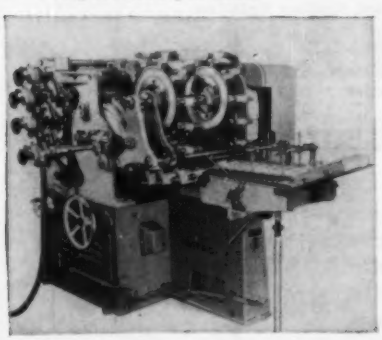
Pressure-sensitive polyethylene tape sustains its tack and flexibility throughout a temperature range of -50° F to 225° F. It's stretchable, conforms to most surfaces to which it is applied, resists water and many chemicals. The bond between the permanent adhesive backing and the four-mil polyethylene surface is said to be excellent. Potential applications of the new, high-tack tape include freezer packaging, closure and sealing of plastic covers and liners, drums and bags.

Giant blow molding equipment turns out thin-wall drum liners of polyethylene at the rate of 120 to 150 per hour. The two-station prototype illustrated has produced containers up to 80 gallons in capacity; is considered capable of blowing objects twice the size without difficulty. Molds operate alternately.



New blow molding machine has produced objects 15 to 80 gallons in size, including 55-gallon drum liners made of U.S.I.'s PETROTHENE 106 polyethylene resin.

Automatic bottle printing machine developed in Switzerland is now being distributed in the U. S. It prints in dry offset—up to four colors in a single operation. Handles cylindrical polyethylene bottles with a diameter range of one to four inches and a printing length of 8¼ inches; or, bottles up to approximately five inches in diameter without printing the whole circumference. Maximum output: 2500 per hour.



U. S. I. Predicts New FDA Ruling Will Spur Food Packaging Use Of Polyethylene

Broader Acceptance of Film, Laminates and Molded Containers Anticipated

The Food and Drug Administration's recent approval of specification-grade polyethylene for food packaging is expected to result in significantly greater use of this versatile plastic. Explains William P. Marsh, Jr.,

Effects of FDA's regulation approving specification-grade polyethylene as a food packaging material will soon be reflected in supermarkets across the country. Sharp rise in polyethylene-packaged meats and dairy products is foreseen.

Vice President and Assistant General Manager of Chemical Operations, U. S. Industrial Chemicals Co.: "Although polyethylene has been sold as a food packaging material for some time, many processors have preferred to await FDA's position before investing in development and equipment.

"With approval granted, we look to polyethylene's natural advantages to be put to substantially increased use for packaging butter, cheese, cream and other dairy products—as well as for both fresh and frozen meats. It's just the stimulus needed to spark considerably higher sales in this major market."

Mr. Marsh feels the rise in polyethylene food packaging will be immediately apparent and will have several forms: film; board, foil and cellophane laminates; molded cups; and vacuum-processed containers.

ALL U.S.I. PETROTHENE® polyethylene resins made for food packaging applications fully comply with the new FDA regulations.

Silage Protected by 7-mil Green Polyethylene Film

Trench and bunker silo covers of new 7-mil green polyethylene film are providing better storage conditions than upright silos—at a fraction of the cost. The green pigmentation helps ward off harmful ultraviolet sun rays and is pleasing to the eyes. Furthermore, the film guards against oxygen attack on silage nutrients and still allows for escape of excess gases which form during storing. The 7-mil thickness provides strength for serviceability and long life.

U.S.I.'s PETROTHENE polyethylene is used in the production of the covers. Explains the manufacturer: ". . . because no weak spots can be tolerated, we insist on resins of utmost reliability and uniformity."

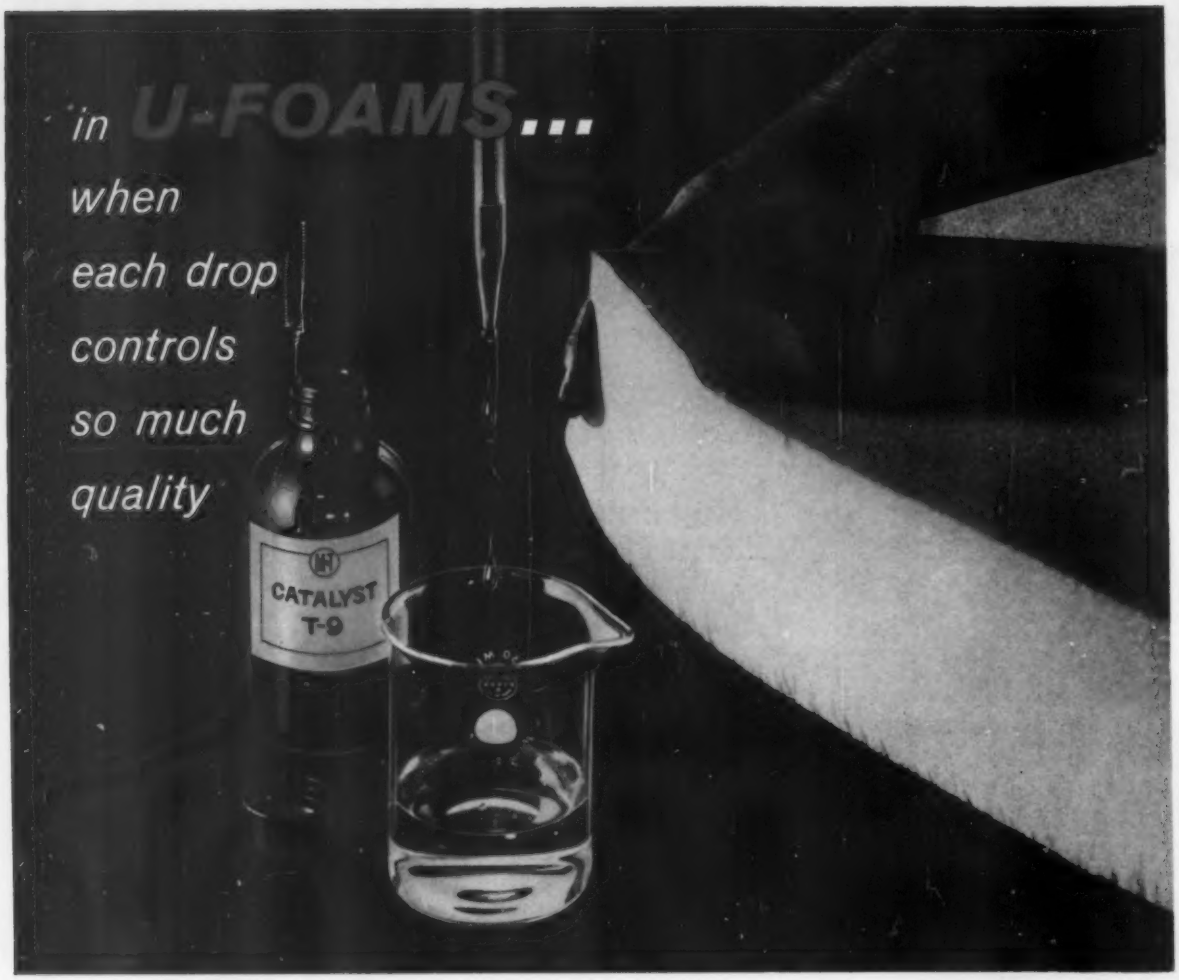
The new film is also being used as ice rink liners and swimming pool covers.

Improved Mold Decorating Process Developed

Look for a new look in molded polyethylene products. A Youngstown, Ohio company reports a unique process said to make it possible to decorate even deep cavities of molds in almost any pattern of grain desired.

According to the announcement, "practically any design that can be drawn in line" can now be incorporated in either cavity and core molds for injection and blow molding or in dies for compression molding. To date the method has been used for houseware, automotive, TV and radio products.

Advantages claimed for decorating molded products: increases sales appeal; provides a durable, mar-resistant finish; offers functional improvements and economies to molders — such as air release for blow molding, etc. A lessening of static charges is also believed to result, but this has not yet been fully explored.



...why take risks on uneven catalyst activity?

Today, the most uniform economical urethane foams are being made with a new catalyst produced by M&T, the pioneer in the development of "one-shot" catalysts. This is CATALYST T-9,* specially manufactured to give a predictably high activity that is retained through normal storage and use. Because of its proved performance, M&T CATALYST T-9 has replaced stannous octoate in most "one-shot" systems, establishing new standards for fast and dependable reaction catalysis and foam uniformity.

Obtain more information about CATALYST T-9 by writing or calling Metal & Thermit Corporation, the only company that produces a complete line of tin catalysts.

*Pat. Applied For

M&T "ONE-SHOT" CATALYSTS INCLUDE:

M&T CATALYST T-9 (stannous type)
Stannous Octoate and Stabilized Stannous Octoate
M&T CATALYST T-12 (organotin type)
M&T CATALYST T-8 (dibutyltin di-2-ethylhexoate)

OTHER M&T PRODUCTS FOR PLASTICS:

THERMOLITE® Organotin Vinyl Stabilizers
THERMOLITE® Ba-Cd and Auxiliary Stabilizers
THERMOGUARD® H- High Tinctorial Strength Antimony Flame Retarder
THERMOGUARD® L- Low Tinctorial Strength Antimony Flame Retarder

®Trade Mark

M&T Chemicals

Sn Sb P | inorganics and
Si Ti Zr | organometallics

METAL & THERMIT Corporation, Rahway, N. J.

In Canada: M&T Products of Canada Ltd., Rexdale, Ontario

Among the four types of

MINI-JECTOR

Reg. U. S. Pat. Off.

PLASTIC INJECTION MOLDING MACHINES

one will do your molding

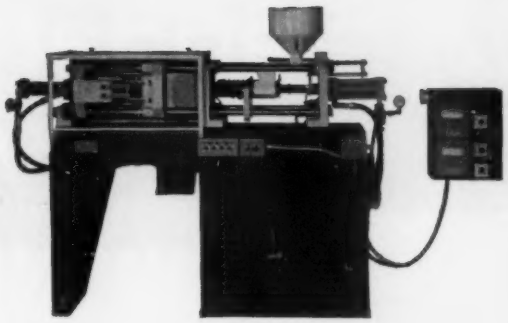
(sub-miniature to 2 Oz.)

better . . . for less.

Whatever your plastic injection molding problem, from sub-miniature to 2 oz., a MINI-JECTOR plastic injection molding machine will fit your precise needs. They're the ideal answer to profitable, precise molding whether it's fast, steady, low-cost production or laboratory experimentation.

MINI-JECTORS mold all thermoplastics, including nylon, quicker, better, for less.

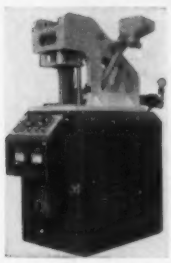
MINI-JECTORS cost less . . . models start under $1,000 . . . Mold blanks as low as $29.50.



IMPERIAL MINI-JECTOR

Fully automatic. Up to 2 oz. capacity. Hydraulic. Approximately 42 tons clamping pressure. 9" x 12" mold area. Up to 10 cycles per minute. Interchangeable cylinders. Horizontal clamping 2-zone heating cylinder. Prepack stroke—$6,470.

ELDORADO MINI-JECTORS

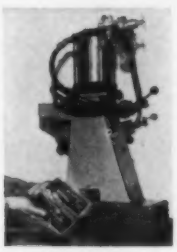


Semi-automatic and Manual. Up to 1½ oz. capacity. Mold area 6" x 5⅛" x 5". Hydraulic power. Ideal for molding involving inserts or loose cores. $4,975. and $3,385.

HORNET MINI-JECTORS

Fully automatic, semi-automatic, manual. Horizontal clamping. Capacity to 1 oz. Air or hydraulic. From $1,785. to $3,600.

WASP MINI-JECTORS



Manual operation. Up to ¾ oz. capacity. Air or hydraulic. Uses inexpensive, self-locking "V" molds. Ideal for molding involving inserts or loose cores. From $965. to $2,368.

Write for FREE catalog get complete data and prices

New, useful, illustrated. Shows fast, low-cost way to develop and produce molded items in all thermoplastics. Shows how to cut your molding costs. Fill in coupon NOW!

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P.O. Box 81, Newbury, Ohio

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For convenience attach to your letterhead and mail.

THAT EXTRA TOUCH OF GRACE: Financial Counseling

The difference between a profit and a loss often hinges on a single financial decision. Competition in plastics products is so fierce these days that how you handle your inventory control, working capital or mold costs can change the color of the ink on your P&L statement. Your Grace representative offers financial counseling as one of the ten major services available under the Grace Service Plan. Ask him how we can put that extra touch of Grace to work for you.

W. R. GRACE & CO. POLYMER CHEMICALS DIVISION, CLIFTON, N. J.

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GRACE PLASTICS

THE PLASTISCOPE*

News and interpretations of the news — By R. L. Van Boskirk

Section 2 — August 1961

When will vinyl chloride prices firm up?

The answer is: when demand becomes more brisk—maybe this fall, maybe not. The industry would like to see an average consumption of at least 80 million lb. per month. Last year's consumption was around 900 million lb. but capacity, current or building, is between 1.3 and 1.4 billion lb., with several companies still insisting that they are going to build additional capacity.

The monomer situation is even worse from an over-capacity viewpoint, with some critics complaining that the steady reduction in price is the reason for unsteady polymer prices. Most of the monomer producers who don't make resin are in the business in order to use a by-product of their major chemical operations and apparently do business at little or no profit. But the capacity of the 11 resin producers who buy monomer is estimated at under 500 million lb., or not much over one-third of total polymer capacity. Furthermore, their total share of sales is thought to be less than one-third, compared with the more-than-two-thirds of the nine resin producers who own their own monomer facilities. These non-producers of monomer can complicate the price structure, but they would do so regardless of monomer price. The chief reason for price problems in vinyl chloride is over-capacity in the polymer ranks—monomer is simply one of many facets.

Take a look at the record as printed by the Tariff Commission. The only 80-million-lb. months for polymer sales in 1960 were August (82 million lb.) and October (80). There were only three additional months over 75 million pounds. The best month in 1961 so far was probably May with around 81.5 million. These figures are a little low, since two or three companies do not report on a monthly basis, but they are accurate enough to indicate the trend. The industry needs at least a few months' running when sales will hit 80 million lb. or more, but it needs, even more, some 90-million-lb. months to get into that billion-lb. classification. That day will come in the not too distant future, for vinyl is far from a static plastic, but until it does the price situation will be doubtful. There are just too many hungry wolves around who will sell on a low-price basis—they just can't stand the gaff of owning a facility that isn't producing on a 90 to 100% basis.

What started the price drops in vinyl?

The list price of general-purpose vinyl chloride dropped to 17½¢ in May. Its history in the last four or five years has been from 27¢ to 25 to 23½ to 22 to 19½ to 17½ cents. The last figure is not firm. When a supplier finds a customer with a bonafide lower price offer, he must often meet it to hold that customer. There are still a good number of high-quality houses buying 17½¢ resin because they prefer to maintain a reliable, proven supply source that has been built up over the years, but every now and then one more succumbs to price pressure.

The last price decline came after what might be called the third wave of expansion in capacity in the last five years. The first two came while vinyl chloride was enjoying one of its several booms—when sales were increasing

*Reg. U.S. Pat. Off.

RESEARCH REPORT

MOL-REZ SYNTHETIC RESINS

PLEOGEN 4015

FIRE-RETARDANT FOAM SYSTEM

At last—a urethane foam system giving flame-resistance without sacrificing strength, dimensional stability, or other desirable properties.

You need self-extinguishing foam? You can have even better! Foam from PLEOGEN 4015 polyether foam system rates NON-BURNING by ASTM test. Achieved by built-in resistance; no additives used to cause poor physicals or poor humid aging. And the low viscosity of polyether resins is retained. This type of foam is indispensable for insulation in the building industry.

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from 50 to as much as 200 million lb. from one year to another. There were price declines during these periods, too, as mentioned above. But absorption of those customers who had been buying foreign resins and an ever-increasing demand for vinyl chloride took care of these two expansion waves without more than the usual talk about the dangers of price cutting.

The third expansion wave hit in early 1960, at the time that sales fell off as a result of the general economic decline. The boom had bust. Many comparatively new polymer producers had a big surplus and had to dig hard for customers. Since there were no new or expanded markets or customers opening up due to the decline of general business they went after the existing ones, just as has happened in every industry under the sun when the squeeze is on between demand and supply.

What will be the long-term effect?

One thing seems certain. The pioneer producers are not going to back out of vinyl. They also expect to make a profit. The same thing applies to most of those who have entered the business since 1955 or thereabouts. In fact, there are even newcomers threatening to get into the business.

So what happens? Producers are going to think about manufacturing resins that will give the best profit yield; they will curtail that little bit of extra effort that implies higher quality and give up on many applications that require variations of general-purpose resin. There will be a minimum of research and development, no promotion of their own or customers' products, very little technical service. Vinyl chloride will become a commodity like corn or wheat, and the customer who uses it will have to do all the promotion. It could well become a chemical like sulfuric acid or chlorine with big volume and small profit.

Another disturbing factor for future consideration is the expanding growth of imported vinyl calendered goods such as inflatables, rainwear, even shower curtains and tablecloths; and rising imports of foreign cars have cut into domestic auto makers' consumption of vinyl for interiors. The government has already refused increased import duty on vinyl raincoats on the theory that imports did not injure domestic trade because "a considerable part of the imports flow through a distribution system not utilized by domestic producers, and most of the imports are sold in a price range much below the price range of the bulk of the domestic production." A dissenting member of the Tariff Commission said: "The reason domestic raincoats were not offered in the low price range was because they were undersold by imports and injury had already occurred."

Pattern for the future

It is a daring man who will predict an organization chart for the plastics industry five years from now. Integration and combinations of one sort or another are increasing by the week. A few of the recent developments contributing to this so-far conglomerated pattern are as follows:

Appointment of Charles M. Scholz, formerly of Landers Corp., as vinyl sales manager of Ford Motor Co.'s new Motorcraft Div. This is a significant indication of what may happen when a large captive processor has more than enough capacity to suit his own needs. Ford gives every indication of becoming one of the largest vinyl chloride processors in the country.

Another quite different event was Spencer Chemical's acquisition of two packaging material processors. One was Crystal Tube Corp., Chicago, Ill.,

J. Neipris, President, The Blane Corporation
Canton, Mass.

Blane Corporation President says,

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"We can't take a chance on resin variations," says Joe Neipris, Blane Corp. President. "We manufacture specification PVC compounds for the wire and cable industry and get consistently good electrical properties with Vygen 120. In our Custom Compound Division we specify Vygen 85 for molding compounds and Vygen 105 in 'Clears' because of its superior clarity. General's Chemical Division, in cooperation with our own Technical Staff, has helped in the development of a range of dependable PVC Compounds for the Wire and Cable Industry, for molding and for profile extrusions. For top quality and fast service, we count on Vygen."

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which started in business almost 30 years ago as a producer of cellophane cigar wrappers. The company now designs, prints, and makes bags from purchased polyethylene, cellophane, laminates, and other flexible materials.

The other acquisition was Flexicraft Industries, New York, N. Y., another converter of flexible films. Both of these companies will maintain their present management. Reasons given for the move were to obtain more financial and technical resources for the converters, and to obtain first-hand information and technical data on packaging for Spencer. The latter states that it has no intention of making film.

Other forms in the plastics pattern

Owens-Illinois and National Distillers have formed a joint company called National Petro Chemicals Corp., which will operate a previously announced 60-million-lb. low-pressure polyethylene plant in Houston, Texas, part of which will be used to produce blown plastic bottles, of which O-I is one of the largest producers. U.S.I. Chemicals Div. of National Distillers, which now produces conventional PE, will supervise construction. National Distillers had been a big customer of U.S.I. for many years, and their close relationship, no doubt, brought them together. Their Kordite film operation, and now a big bottle operation, assures them of a large market for resin.

The business of a producer buying a processor is now one of the more common moves in the industry pattern—part of this springs from over-capacity among resin producers and the need of more capital by processors, many of whom have been operating at a very low profit margin and want to expand into more volume.

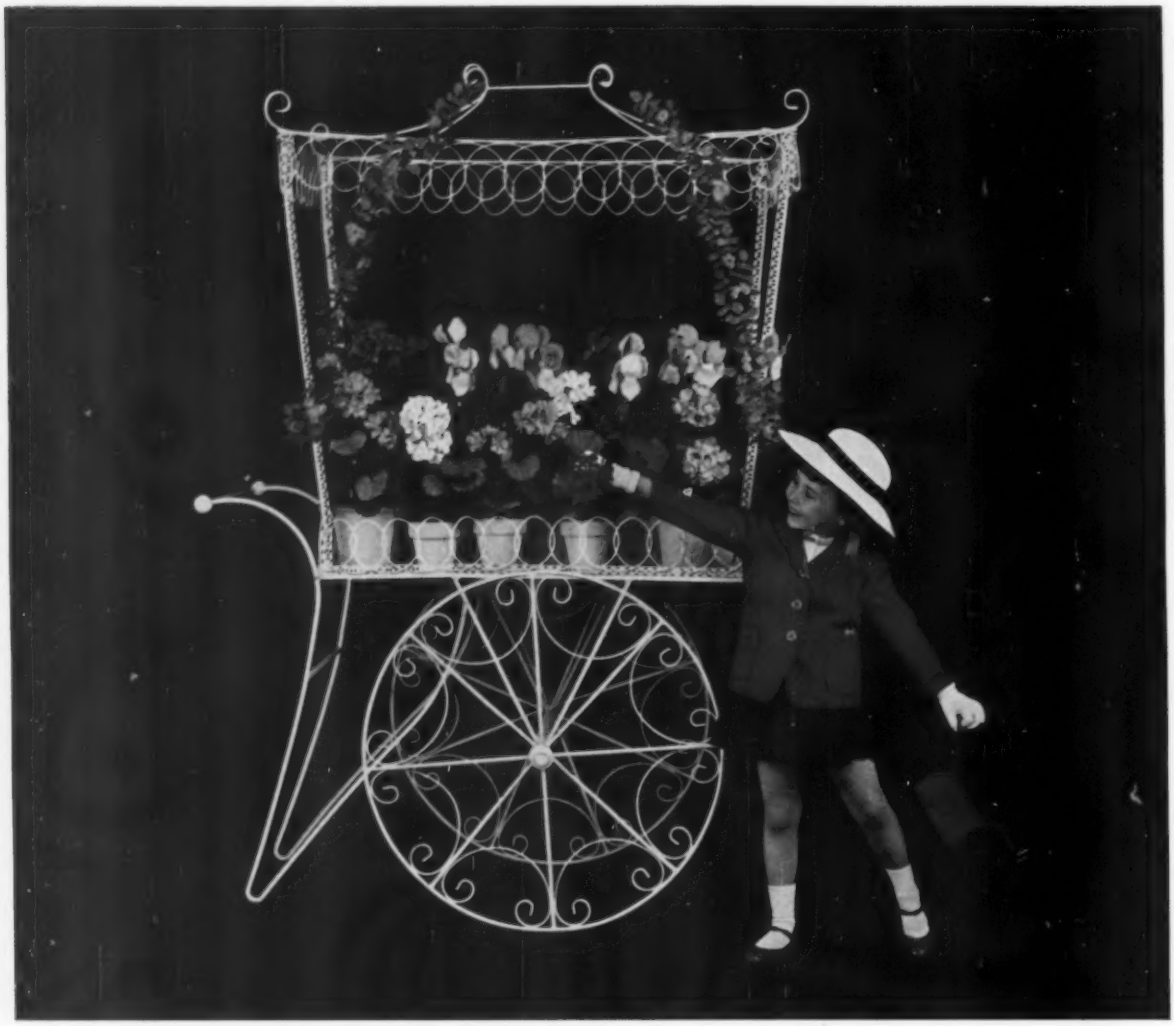
Still another and different type of association was the acquisition by Courtaulds (an English firm) of 5% of Koppers Co. stock. Courtaulds is active in the viscose fiber field, is a producer of chemicals, cellophane, packaging film, and paint, and has interests in pulp and plastics. The first step in this combination is to combine the research activities of the two companies. Both have world-wide interests—by combining and melding their joint research in resins and resin products they both expect to gain far more benefit than when working alone. They may never undertake a joint venture, but each will have the benefit of the other's study and experience in resins and what can be made from them. The combination of research activities by large companies on a world-wide basis could well become one of the finest money-saving, fruitful experiences ever embarked upon by the chemical industry.

Allied Chemical blankets urethane area

With the announcement that its new 20-million-lb./year Actol polyether plant was ready to produce and that a plant had been previously authorized to produce rigid urethane foam, Allied Chemical is now engaged in practically every facet of urethane production.

The first move was the entry of its National Aniline Div. into isocyanate production in West Virginia in 1953. A new 15-million-lb. plant will soon be built in Southern California. Isocyanate is the basic chemical from which urethanes are produced.

However, it is necessary to react isocyanate with either polyesters or polyethers to produce foam. Polyesters are produced by the company's Plastics Div. The Solvay Process Div. is now producing polyethers which have crowded



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out a great portion of the polyesters. They are in the 20-to-30¢/lb. range compared to the 40¢-or-more polyesters. Polyethers also improved the cushioning properties of flexible foam to broaden its markets—only inner lining is left for polyesters in this area. For some time it seemed that polyesters would be most satisfactory for rigid foam, but here, too, polyether is moving rapidly into the field.

Another branch of the company, General Chemicals, produces fluorocarbon blowing agents which are necessary in the manufacture of foam. The tradename of the blowing agent is Genetron.

The Barrett Div. will operate the rigid foam plant and distribute it along with its other building products and promote its general use as an aid to other foam end-users. Allied will soon have spent more than $28 million in research and development of urethane.

Urethane's position in rigid foam

Allied analysts state that industry-wide sales of rigid urethane foams in 1960 were $12 to $15 million and will be around $110 to $120 million in 1965. The big upsurge is expected in construction. Allied itself has used sizable quantities, from its semi-commercial plant, for insulated roof decking at company plants in Chesterfield, Va., and Irmo, S. C., as well as its New York office building.

The potential for rigid board includes uses for low-temperature space insulation, roof insulation, pipe and vessel insulation, perimeter and floor slab insulation, wall cavity and plaster base insulation, backerboard-metal siding, floating structures, non-residential panels.

Flammability is one major performance problem. Development of a self-extinguishing foam or a durable fire-protective coating is desirable. Several prospects in this area are on the way.

Five years ago there were only 75 companies purchasing materials for urethane products. Today there are almost 1000. Annual production capacity today is, or soon will be, 125 million lb. of isocyanates and seven major producers now have capacity for 175 to 200 million lb. of polyether. This is enough to fill demand for a long time to come.

Nopco also claims integration

Nopco Chemical of North Arlington, N. J., which states it is the largest foam producer in the world, is also approaching integration with the near completion of its new plant at Linden, N. J., for producing isocyanate. Expansion plans this year include a one-third increase in foam production at headquarters; a new foaming and fabricating plant at Chattanooga, Tenn.; a similar facility in the Midwest; additional new plant space for foam fabricating; and acquisition of six foam fabricating companies in the Midwest. The company has also recently acquired the Brown Rubber Co. Inc. of Lafayette, Ind., and will install urethane foam production facilities there. Brown, formerly a processor of vinyl and other foams, had suspended operations.

Ed. note: Nopco also called particular attention to a gross error concerning foam production in this column in June. The correction is that "a large-size foaming operation can produce approximately 46,000 cu. ft. of foam per shift, or 69,000 lb. when using 1.5-lb./cu.-ft. foam as a basis." The giant-size error printed by mistake said 3 to 4.5 million pounds.

For additional and more detailed news see Section 2, starting on p. 178

NEW MACHINERY-EQUIPMENT

Specifications, claims made, and prices appearing in these pages are those of the manufacturers or sellers of the machinery and equipment described, or their agents.*

Extruded pipe puller with novel design

The PGIV (positive grip-infinitely variable) extruded pipe puller is equipped with eight pipe grippers positioned on either side of the pipe in such a fashion so that three grippers on either side are in contact with the pipe as it travels through the puller; the grippers travel with the pipe. The ingenious geometrical design of the pipe grippers provides for complete circumferential contact with the O.D. of the pipe, and complete adjustability of the grippers to handle any size pipe between 0.25 to 4.5 in. (O.D.). Because of the circumferential contact of the puller, distortion of the pipe is eliminated even on extremely thin-wall tubing. The puller will handle pipe at rates between 3 in./min. and 23 ft./min.; special ranges are also available. Operating height of the puller is adjustable from 37 to 44 in. for use with most extruders. Grippers are lined with Neoprene for traction. *Al-Be Industries Inc., 9516 Rayo St., South Gate, Calif.*

Injection machine

Three models—350TC, 350TCL, and 450TC—of the Reed-Prentice injection machine are now being offered with screw plastication. All three machines are equipped with the same injection system in which a 3 7/16-in. diameter screw is used, driven by a 15-hp. motor, and having a speed range of 12 to 120 r.p.m. All are rated to plasticate material at the rate of 200 lb./hr. and deliver 57.5 cu. in. per shot, at a rate of 32.3 cu. in./sec. at maximum injection pressures of 18,000 p.s.i. Machines differ mainly in casting area, which is available in sizes of 178, 186, and 240 sq. in. with corresponding clamp forces of 356, 372, and 524 tons for the models listed above, respectively. Mold space for the first two models is 20½ in. square; 26 in. square for the 450TC model. Daylight openings are 36½, 44¾, and 47⅛ in. for the models in the order shown. Machines may be operated full or semi-automatic. *Reed-Prentice, Div. of Package Machinery Co., East Longmeadow, Mass.*

Pipe extrusion monitor

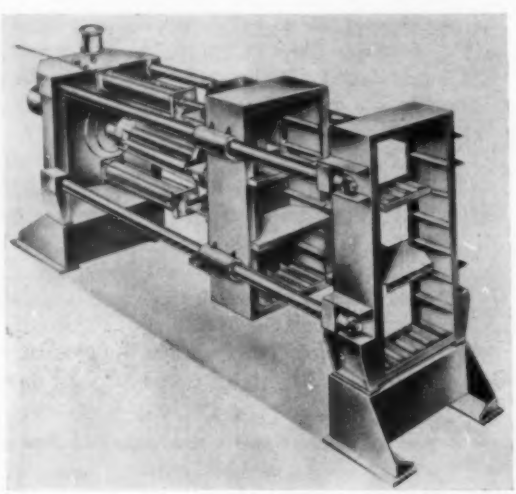
The Haynes and Haynes plastic tube monitor is designed to measure and record the wall thickness of plastic tubing continuously as it is being extruded. It responds to rapid changes as well as long term variations. One model may be used to automatically control the average wall thickness. The wall thickness is measured by means of a detector head, which is clipped around the tube at its exit from the cooling tank. The head contains two capacities, which are part of a bridge circuit. One is a calibrated capacity which is balanced against a capacity which is proportional to the thickness of the pipe passing through the head. An imbalance produces an error voltage which is proportional to the thickness variation and which is indicated and recorded. The voltage may also be used to control the haul-off unit to correct wall thickness variations. Pipes with outer diameters from 0.470 to 7.280 in. and of any thickness can be handled by selecting the head with the proper range. *West Instrument Corp., 4363 W. Montrose Ave., Chicago 41, Ill.*

Engraver

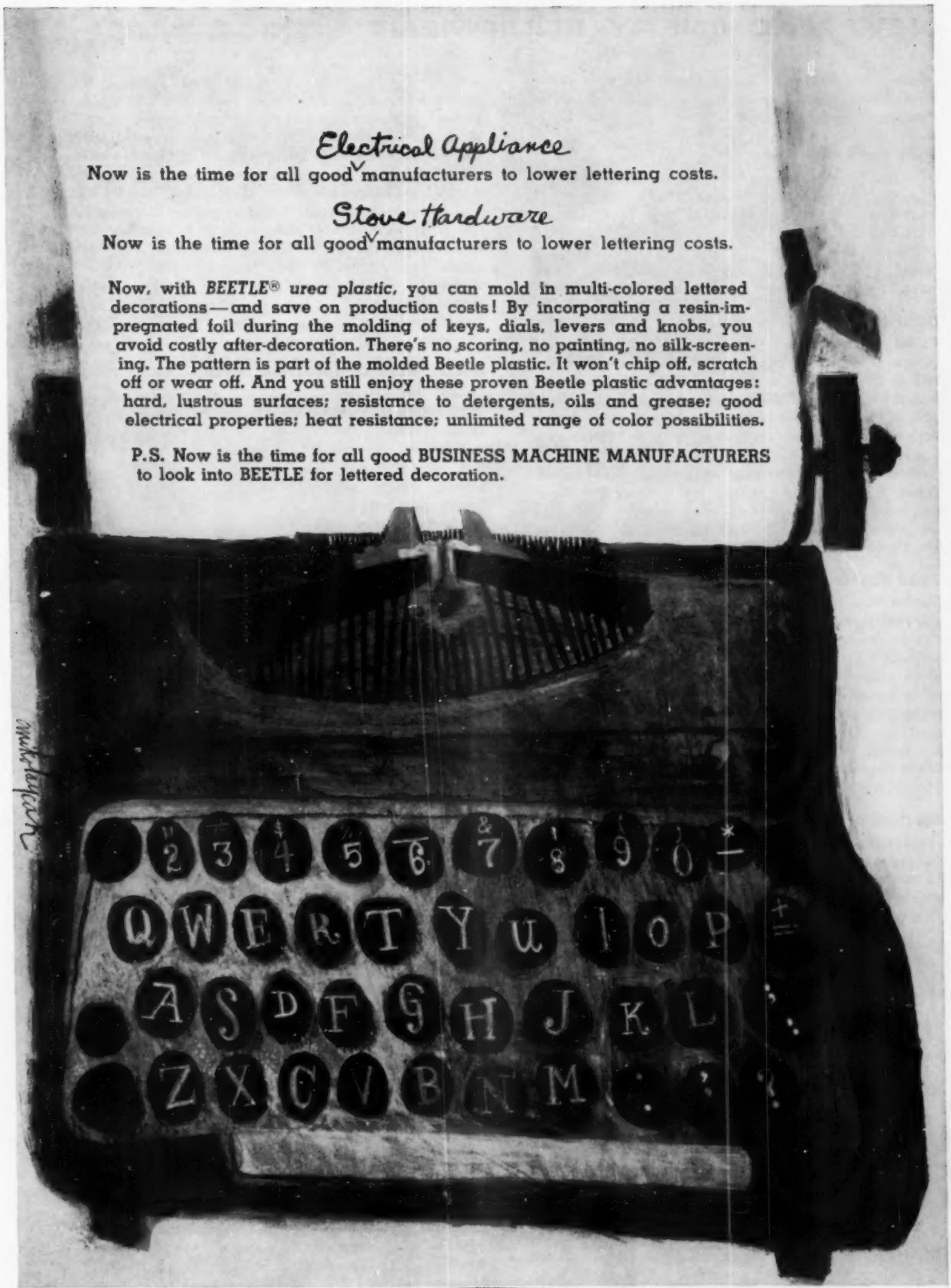
Identified as the Catalog No. 252D-6R Pantograph Engraver, this Mico unit was developed especially for multiline engraving work on the larger types of plastic desk and door signs. The machine uses the manufacturer's standard engraver components, but has new copy-carriers, adjustable work holding fence, constant depth attachment, and carbide-tipped, tapered shank cutters. These new accessories are said to permit engraving over greater areas and at the same time require fewer set-ups of the work and the master copy. *Mico Instrument Co., 80 Trowbridge St., Cambridge 38, Mass.*

Foam molding machine

Designed for the molding of expandable polystyrene foam, the Tronomatic molding press will handle single or multiple molds which have an aggregate area up to 30 by 50 in. in size. Clamping force is 50 p.s.i. and is supplied by a special air-hydraulic cylinder. This cylinder has no pumping system, hydraulic piping, or accumulator, thus minimizing maintenance. Any depth of part may be molded, since the stroke of the machine will be modified to meet the user's needs. Standard strokes are 16, 24, 30, and 44 inches. Molds can be mounted on or within the platens. This allows full use of the available stroke capacity. Units are equipped for venting molds during filling and the electrical system is completely waterproofed. Only connections to utilities are required in order to make the machine op-



* Prices are deemed to be F.O.B. sellers' plants (unless otherwise stated), are for "standard" models, and are subject to change without notice. The publishers and editors of **Modern Plastics** do not warrant and do not assume any responsibility whatsoever for the correctness of the same or otherwise.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erative. Four larger platen area presses and other custom engineered models are available. *Tronomatic Corp., 25 Bruckner Blvd., New York 54, N. Y.*

Pipe marker

The Model 15AE plastic pipe marker is mounted "in line" with extrusion equipment and imprints the pipe with trademarks, etc., immediately before it is coiled. The unit includes a maximum imprint area of 24 by 1.75 in., with imprint repetition every 1, 2, 3, 4, 6, 8, 12 or 24 inches. Speed of printing is such to keep up with most extruder rates. *Markem Machine Co., Keene 50, N. H.*

Blast finishing equipment

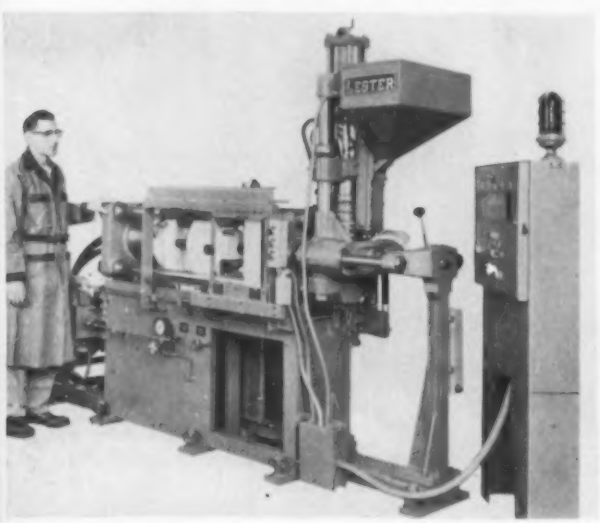
Called Supersonic Blast, this machine uses a high-speed stream of air containing abrasive powder (particle size is 3 to 100 microns) to deburr, deflash, peen, or micro-inch finish plastic parts. Two models are available: Model 300, which is hand gun operated; and Model 400, which is designed for automatic parts handling. Both models come equipped with self-contained filtering systems, powder feeders, air compressors, and water-cooled dessicant air dryers. A third model, 2400, is the same as the Model 400, but has dual operating stations. *Supersonic Blast Inc., Div. of American Brush Machinery Inc., 29 Elm Ave., Mt. Vernon, N. Y.*

Band heater

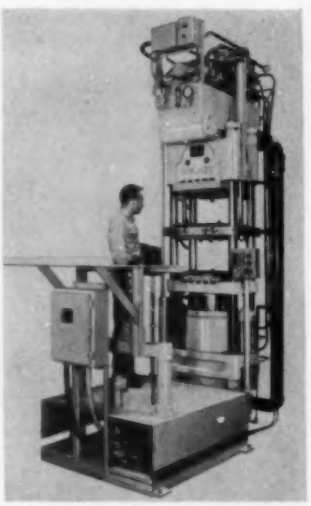
Starflex band heaters are designed so that parts are interchangeable; spare parts rather than complete heater assemblies may be ordered for replacement. The body of the heater is of extruded aluminum with grooves into which tubular heaters may be snapped. The outer cover of the heater is made of nickel-base alloy with a low coefficient of expansion. In addition to reflecting heat inward, the alloy strap cover tends to tighten the band as it is heated. The heater bands are standardized in ¼-in. heater diameter increments; special sizes are available. *Glenn Electric Heater Corp., 372 Jellif Ave., Newark, N. J.*

Injection press

The Lester Model L-100-2/3 machine has an injection shot capacity of 1.5 to 2.25 or 2 to 3.25 oz., depending on the material and whether a single-stroke or double-stroke feed is used. The machine has an injection plunger with a diameter of 1 9/16 in. which has a maximum stroke of 5.5 in., which is completed, with rapid advance, in 0.8 seconds. Plunger displacement speed, with rapid advance is 14.2 cu. in./sec., which slows down to 7.3 cu. in./sec. during final fill. Recommended casting area at maximum injection pressure of 20,400 p.s.i. is 35 to 40 sq. in., depending on material and mold construction. Mold closing force (S.P.I. Test Method) is 100 tons. Stationary platen is 19 in. wide and 17 in. high; movable platen is 20 by 18 inches. Clearance between tie bars is 12.5 in. horizontally; 10.5 in. vertically. Maximum die space between platens is 15 in., and mold operating time is 1.6 seconds. Complete machine cycle (idling) is 3.7 seconds. Total heater power is 10.4 kw. Motor hp. is 25 minimum. *Lester-Phoenix Inc., 2711 Church St., Cleveland 13, Ohio.*



Double-deck compression press



Called the Hydro-Moldic production molding press, this machine is equipped with three platens: bottom, center, and upper. Two sets of molds may be run in the same press by mounting one set between the lower and center platens, and another mold set between the center and upper platens. The upper molds are loaded first; the lower half of the upper mold then rises so that the lower mold may be loaded; the press then closes to apply molding pressure to both of the mold sets. Both transfer and compression molds may be used. Standard press sizes come with platens either 20, 24, or 32 in. square. Standard models are furnished with the hydraulic power system mounted overhead on the press, but models may be supplied for use with a central hydraulic supply system. *Stanley H. Holmes Co., 4601 N. Ronald Ave., Harwood Heights, Chicago 31, Ill.*

Mold temperature coolant controller

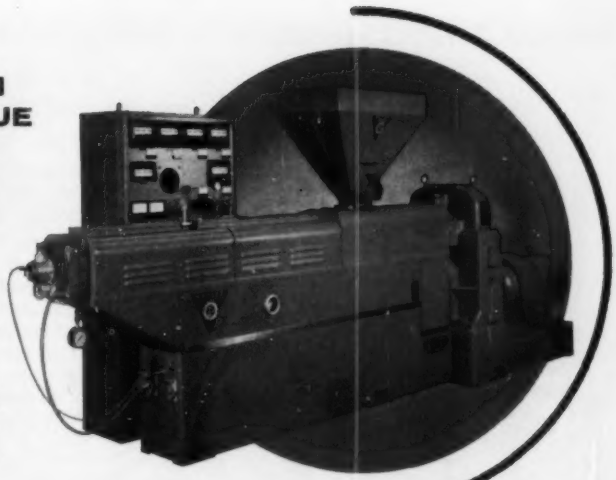
Designated Model 6016, this mold coolant temperature controller is one of several models designed to circulate heat transfer fluids at higher than normal temperatures (up to 550° F.), such as those common to water circulation systems. Using heat transfer fluids, rather than water, also allows the unit to operate at lower pressures, thereby eliminating the hazards associated with high pressures. Fluid is circulated in the Sterlco unit by a heavy-duty, high-temperature-type, positive displacement pump with a capacity of either 10 or 18 g.p.m. *Sterling Inc., 5206 W. Clinton Ave., Milwaukee 3, Wis.*

Blow molder

The Stokes Model 855-2 blow molding machine has included, as standard equipment, a material manifold, parison cross-heads with control instruments, parison cutters, and photocell safety device. Dual parison cross-heads are optional equipment. Dry cycling rate (without cooling) is 1500 per hour. Typical output with a Stokes Model 850, 2½-in.; 20:1-L/D-ratio extruder is rated at 75 to 100 lb./

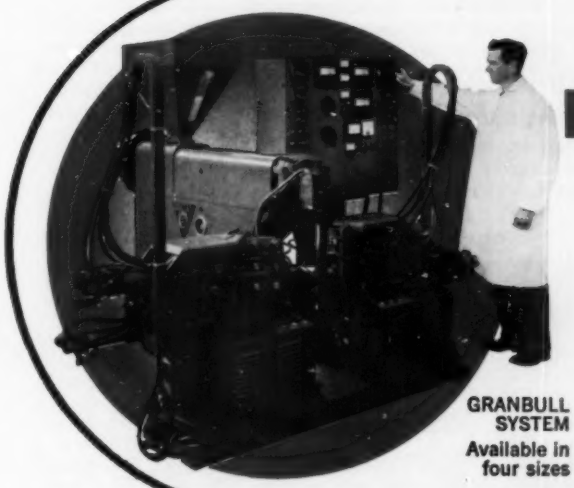
Years Ahead!

PRODEX HIGH TORQUE EXTRUDERS with CHANGE GEARS



now permit you to select quickly the optimum reduction ratio and screw speed necessary to extrude **either high or low viscosity materials** at maximum horsepower efficiency and highest possible production rate for each extrusion job.

Prodex extruders give you the best possible machine return on your investment of any extruders in the world today. These machines are built vented or non-vented in a complete range from 1¾" to 10".



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Prodex blow molders, for maximum output and reliability of operation, are supplied with specially designed, high-performance **Prodex extruders.**

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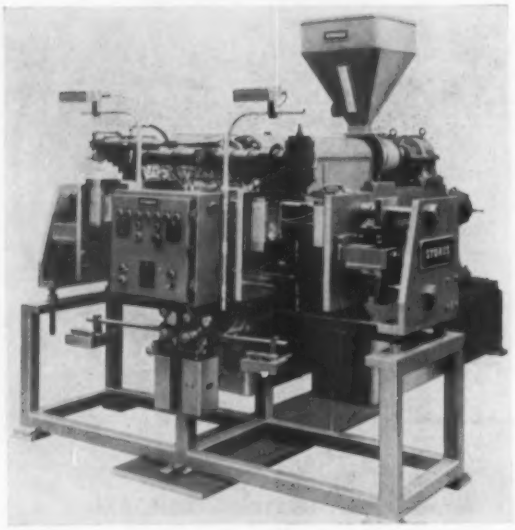
NEW MACHINERY-EQUIPMENT

Specifications and claims are those of the manufacturers and/or their agents.



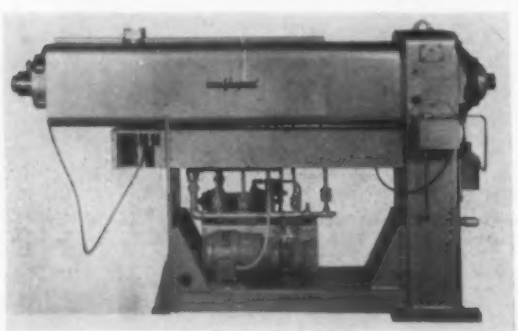
hr. Maximum part size is 7¾ in. (diam.) by 28 in. long. Platens are 10 in. wide by 20 in. long, as is the mold area. Mold length is 30 in., (mold length clearance is 50 in.). Maximum stroke and daylight are 8 and 18 in., respectively. Minimum mold thickness is 3 inches. Manifold heaters require 8 kw. at 220 v. single-phase: extruder heaters 18 kw. at 220 v. single-phase. Air supply must provide 2 hp. at 100 p.s.i. pressure. *F. J. Stokes Corp., 5500 Tabor Rd., Philadelphia 20, Pa.*

Drum tumbler

A modification of the manufacturer's standard line of Fig. 730 drum tumblers, the hydraulic-lift drum tumbler takes the manual work and physical injury hazard out of loading drums into the tumbler. The hydraulic lifts are available on both single- and double-drum tumbler models. Hydraulic drives may be constant or variable speed, and explosionproof units are available. *The U. S. Stoneware Co., Process Equipment Div., Akron 9, Ohio.*

Extruders

Described as the NRM Vanguard Series, the Vanguard II (2½-in. screw) and the Vanguard III (3½-in. screw) extruders are available with L/D ratios of either 20:- or 24:1, with either vented or non-vented barrels, and with either induction or resistance heating combined with either liquid or forced-air cooling. Replacing previous models, horsepower, thrust, and transmission thermal capacity all have been improved to take heavier duty cycles. Building block construction provides for the interchangeability of the machine components so that the units may be easily modified as process requirements change. Maximum outputs of the two machines running polyethylene (Dens., 0.92; M.I., 2) are 150 lb./hr. for Model II and 300 lb./hr. for Model III. Motor horsepower for the extruders is 15 to 40 for the smaller, and 25 to 50 for the larger. All models with exception of larger, higher-L/D-ratio machine have four heating zones with proportioning control; former has five zones. *National Rubber Machinery Co., 47 W. Exchange St., Akron 8, Ohio.*

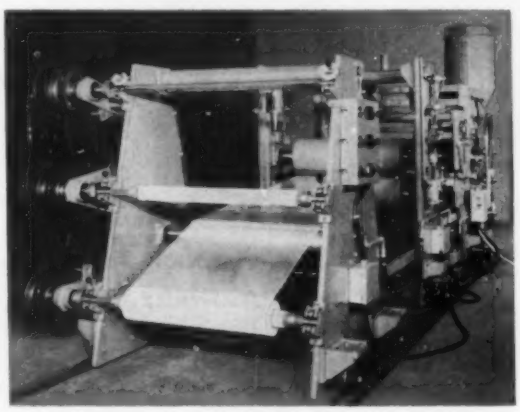


Variable speed drives

Latest addition to the Varidrive line is a 100-hp. dual-belt unit. The line now ranges from ¼- to 100-hp., with units of 50-, 60-, and 75-hp. in the dual belt design. Drives of 40-hp. and below are of single-belt construction. Optional equipment on units up to 60-hp. is a GB gear reducer for low-speed, high-torque applications. Speed-increaser gearing is available for all units up to 100-hp. *U. S. Electrical Motors Inc., Box 2058 Terminal Annex, Los Angeles 54, Calif.*

Sheeting line

A complete, integrated, heavy-duty sheeting line using standard Hartig T-line extruders has been developed for the production of sheet from a wide range of thermoplastics, including polystyrene, acetate, rigid vinyl, polyethylene, and polypropylene. Sheeting widths up to 72 in. at speeds up to 100 ft./min., and a wide range of light to heavy gages can be handled. Auxiliary equipment provided includes plug-in slitters for edge and center cuts, detergent tank for destaticizing agents, conveyors between draw and polishing rolls, and shear cut-off or winders. *Waldron-Hartig Div., Midland-Ross Corp., P. O. Box 531, Westfield, N. J.*



Engraver

The model UM-PC panto-engraver for plastics decorating work is equipped with pneumatic attachment for diamond-drag marking to handle the hardest of materials, including mold steels. The pneumatic attachment controls the depth and width of cut by regulating the air pressure between 0 and 60 lb., and eliminates variations in the cut due to operator error. The pneumatic attachment is said to fit any of the other models of the manufacturer's engravers

PHILLIPS 66 MARLEX® PLASTICS

BRIEFS

REPORT 61-3

Increased Demand for Sheet . . . New Data on Extrusion

As many know, the MARLEX thermoforming rush is on. Every day, we're pleased to say, brings something new—boats, tote boxes, shipping containers, decorative panels, assembly line pallets . . . products, parts, and components of all sizes and shapes. Keeping up with this ever-growing demand is going to be a merry business for present and potential extruders of MARLEX sheet. The stepped-up production will undoubtedly result in a few "prosperity" headaches on the production line. When such technical ills occur, we are always willing to lend a hand with possible remedies. In the last five years, our lab boys have extruded around ½ million pounds of MARLEX sheet . . . sparing no effort to become real "wise apples" on the subject.

Appropriately, we have just published a new Technical Information Bulletin on extruding sheet (replacing one published a while back). Discussed are such questions as the relative merits of MARLEX resin types for sheet . . . requirements for extruders, dies, polishing rolls, temperature controls, cooling conveyors, pull rolls, shears, stackers . . . starting-up procedure . . . quality control . . . typical extrusion conditions . . . and properties of MARLEX sheet. In addition, the bulletin contains an *operating guide* covering many of the *problems* encountered during production, their *possible causes*, and *suggested solutions*. We feel that this operating guide should prove useful even to the old hands at MARLEX sheet extrusion . . . if only as a refresher course on past experience.

MARLEX high density polyethylenes and ethylene copolymers are tough, durable plastics . . . yet are easily extruded on equipment originally developed for high impact styrene. While only minor modifications are required to adapt the sheet extrusion equipment to MARLEX, some additional "know-how" is needed. Our new Technical Information Bulletin #1, Extruded Sheet, is a start on acquiring this extra "savvy". It is available to all interested. Just write or call our nearest office.

TR-515, a New High Density Coating Resin

In early June we announced a new extrusion coating resin, TR-515. TR-515 provides a superior polyethylene coating with new toughness, a wider useable temperature range . . . and greater resistance to moisture, oils, greases and the like. As a result of some lengthy developmental testing, we feel we've got a real winner.

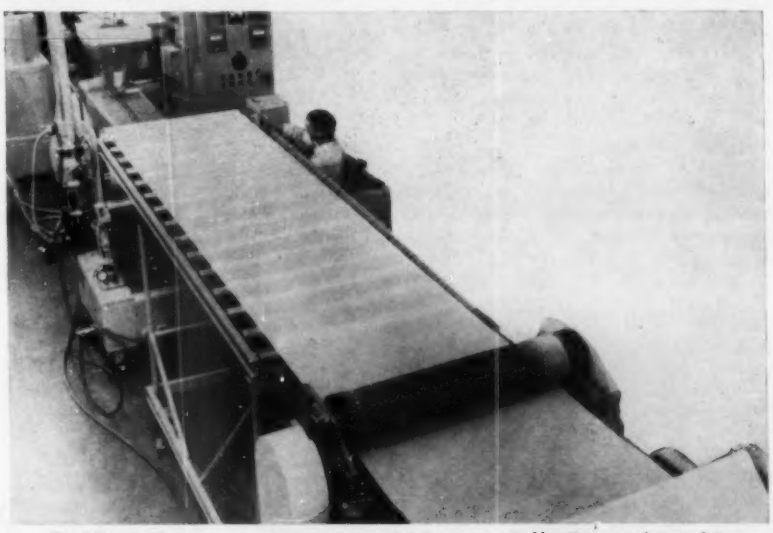
Coating rates with our new TR-515 resin are in excess of 600 feet per minute on standard equipment . . . with thickness less than five pounds per ream being possible. Initially, we expect the big use to be for multiwall bags and pouch paper . . . coated films and foils requiring low moisture transmission and high resistance to greases . . . paperboard products for frozen foods and the like, folding boxes, and corrugated board. Because of the inherent toughness of TR-515, we wouldn't be surprised to see thinner coatings of it replacing thicker coatings of low and medium density poly . . . even in the less critical applications. Write for full details.

By the Seat of the Pants . . . with Imagination

The way in which the furniture industry has taken to MARLEX is heartwarming. Their use of our high density polyethylenes and ethylene copolymers is widespread and well considered. For example, here are some of the furniture items made of MARLEX: highchair trays and footrests . . . interior compartments . . . fabrics of all kinds and textures . . . drawer slides, dowels, and similar hardware . . . decorative panels, covers, and the like . . . and, most significantly, seats, backs, and arm rests for all kinds of chairs from bar stools to stadium seats.

Aside from the volume of this furniture business, what pleases us most is the suitability of the applications to the physical properties of our plastics. In practically every instance our plastics are used where they should be used . . . and used correctly. Our hats are off to the furniture manufacturers, their designers, and plastic fabricators. These fellows, while seemingly thinking about the seat of our collective pants, have used MARLEX both wisely . . . and with imagination.

In the final analysis, the future of MARLEX depends on creative application based on its physical properties—resistances to acids, alkalies, greases, fungi, corrosion, heat, cold . . . its toughness, appearance, molded-in texture and color . . . its ease in molding, thermoforming, extruding, machining, etc. If you want a more complete story here, on the properties and potentials of MARLEX . . . drop us a line, or stop in at any of the offices listed below.



This full-scale, sheet extrusion equipment at our lab has run nearly ½ million pounds in studying the techniques of producing higher quality MARLEX sheet more efficiently.

*MARLEX is a trademark for Phillips family of olefin polymers.

PHILLIPS CHEMICAL COMPANY, *Bartlesville, Oklahoma*

A subsidiary of Phillips Petroleum Company

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EXPORT: PHILLIPS PETROLEUM INTERNATIONAL CORP. • P.O. Box 7239, Panama City, Panama • Sumatrastrasse 27, Zurich 6, Switzerland

Specifications and claims are those of the manufacturers and/or their agents.

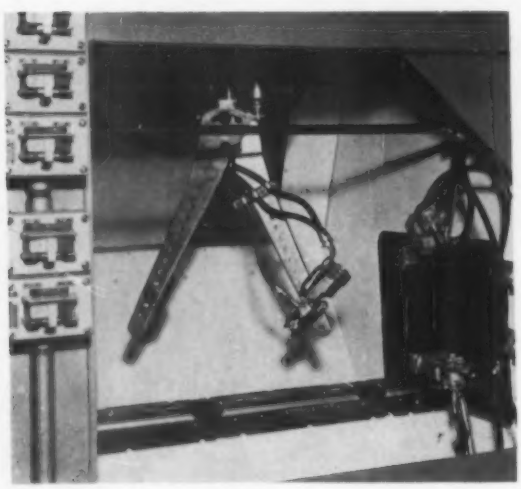
with the exception of Model 2D-4. *H. P. Preis Engraving Machine Co., 250 Industrial Branch, U. S. Highway 22, Hillside, N. J.*

Mold temperature controller unit

The Model J Thermolator is supplied as a self - contained unit, but is designed so that the control cabinet and the operating unit may be separated if the customer so desires. This allows the mounting of the control unit in a remote location. Pumps and heaters are supplied with the unit in accordance with the requirements of the job. Centrifugal pumps with capacities ranging from 10 g.p.m. at 28 p.s.i., to 40 g.p.m. at 100 p.s.i are available in five sizes. Four heater systems ranging from 4.5 to 12 k.w. (divided 2:1 into main and auxiliary sections) are available to cover most molding requirements. Thermostatic control is used to control mold face temperatures to ± 1° F. *Industrial Mfg. Corp., 31 E. Georgia St., Indianapolis 4, Ind.*

Spray painter

Called the Roto-Matic Coater, this spray painting system for the decoration of plastic parts is equipped with a super-high-speed rotating spray gun assembly, thus increasing the production rate up to 10 times that possible with previous units. It operates at 50 to 75 r.p.m. The manufacturer also claims that better coverage of folds, corners, and ridges in the part is an added advantage. Further increases in production rate are said to be possible when the new rotating gun is used on parts which rotate as they are painted. Almost any type of coating can be handled, including epoxies, varnishes, and others. *Finish Engineering Co. Inc., 921 Greengarden Rd., Erie, Pa.*

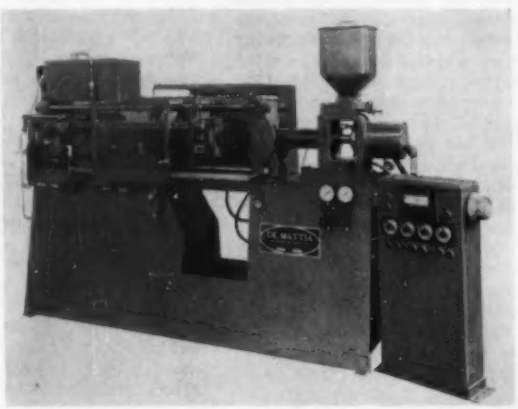


Welding tool

The Seelye Plastic Welder welds most thermoplastics, including plasticized and unplasticized vinyl chloride, polyethylene, and polypropylene. It can be used for butt welds, lap welds, curved welds, and others, with speeds averaging 48 in./min. on simple flat or curved surfaces. Hot nitrogen is used to heat both the area being welded and the welding rod, which is fed automatically through a high-speed tip. The tool is 14 in. long and weighs 14 ounces. Unit is powered by 110-v. a.c. supply. *Seelye Plastic-Fab Inc., 984 Central Ave., Minneapolis 13, Minn.*

Injection machine

Fully hydraulic and automatic in operation, this Model J, 2-oz. injection machine has a plasticating capacity of 50 lb./hr. and a minimum dry cycle time of 3 seconds.



Maximum daylight is 18 in., and clamping force is 56.5 tons. Maximum mold plate size for horizontal insertion is 12 by 15 in.; maximum vertical mold plate size is 8 by 18 inches. *De Mattia Machine & Tool Co., Allwood, Clifton, N. J.*

. . . Machinery in brief

▸ A line of back-geared punch presses ranging in capacity from 2 to 25 tons is designed to give slow, powerful strokes resulting in more advantageous use of flywheel inertia in plastics punching and blanking operations. *Alva Allen Industries, 1001-15 N. 3rd St., Clinton, Mo.*

▸ Spraying applications, pressure- or vacuum-impregnating applications, and the conveying of plastic melts to distant points are among the uses of these new electrically heated low-pressure tanks. *Sta-Warm Electric Co., Ravenna, Ohio.*

▸ Fan-cooled, helical, worm-gear speed reducers are available in ratios from about 34:1 to 394:1. The reducers come in seven sizes with center distances ranging from 4 to 12 inches. Ratings are from fractional to 58.5 hp. *Cleveland Worm & Gear Div., Eaton Mfg. Co., 3300 E. 80th St., Cleveland 4, Ohio.*

▸ The Flexi-Mount Wheel Unit, adjustable to any working angle, will accommodate buffing wheels, wire wheels, Tampico wheels, nylon pile wheels, flat wheels, and others up to 10 in. in diameter used for the finishing of plastics. *J. M. Nash Co., 132 Jackson St., Oshkosh, Wis.*—**End**

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Purity (wt per cent) min.	99.3
Specific Gravity (20/20°C) min.	0.805
max.	0.807
Acidity (as acetic acid—wt per cent) max.	0.002
Color (Hazen) max.	10.0
Non-volatile Matter (mg/100 ml) max.	2.0
Distillation °C	
Initial min.	78.7
Dry Point max.	80.7
Water (wt per cent)	0.2
Residual Odor	None
Appearance	Clear and free of suspended matter

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WORLD-WIDE PLASTICS DIGEST*

Abstracts from the world's literature relative to plastics. For complete articles, send requests direct to publishers. List of addresses is at end of this section.

General

Thermally resistant polymers. S. M. Atlas and H. F. Mark. Angew. Chem. *72*, 249-55 (Apr. 1960). Organic-inorganic polymers are more thermally resistant, up to 550° C., than organic polymers. Recent work in this area is summarized.

Plastics in theory and practice. G. Gee. Plastics Inst. Trans. *29*, 32-38 (Apr. 1961). Polymerization chemistry, elementary flow principles, and bulk properties are reviewed briefly.

New polymers to conduct electricity. Product Eng. *32*, 6 (Jan. 30, 1961). Resins that serve as charge-carriers when dissolved in non-polar organic solvents are reported.

New developments in cellular plastics. A. Cooper. Plastics Inst. Trans. *29*, 39-54 (Apr. 1961). Properties, applications, and methods of making cellular plastics are reviewed. Twenty-six references.

Materials

New strength in polystyrene. J. R. Wilkinson. Modern Packaging *34*, 119-20, 171, 173 (Feb. 1961). A new class of medium-impact polystyrenes combines low cost with excellent impact strength at sub-zero temperatures. The materials achieve good low-temperature impact strength through a reduction in the orientation of the polymer. The major use for this material is expected to be in the field of thin-wall containers for frozen and refrigerated foods.

Synthesis and properties of isotactic and atactic polystyrene graft copolymers. N. A. Plate, V. P. Shibaev, T. I. Patrikeeva, and V. A. Kargin. Vysokomolekuliarnye Soedineniia *3*, 292-98 (Feb. 1961). By ionizing isotactic polystyrene followed by polymerization of monomeric styrene on the resulting polymer, graft copolymers of isotactic and atactic polystyrenes were produced, containing 17, 31, and 35% of the atactic part. The solubility of these polymers in Tetralin is lower than that of linear isotactic polystyrene, owing to growth of the macro-molecules on grafting, and is higher than that of the atactic polymer, owing to the formation of branched chains. Chemically homogeneous graft copolymers of isotactic and atactic polystyrenes are characterized by a clearly defined glassy transition temperature (90° C.) and a high melting point (230° C.), within the limits of which the products are capable of reversible high elastic deformation not accompanied by recrystallization.

* Reg. U.S. Pat. Off.

Molding and fabricating

Effect of shrinkage when injection molding high-density polyethylene. H. Beuschel and H. Peters. Kunststoffe *51*, 182-91 (Apr. 1961). The shrinking of polyethylene, particularly the differences in the direction of flow and in the direction at right angles to it, is a constant problem in injection molding. The significance of the various effects of shrinkage as well as the cause of shrinkage stresses and distortion cracks are briefly discussed.

Molding tolerances are key factors for plastic parts. R. Smith. Space/Aeronautics *35*, 95-96, 98, 100, 102 (May 1961). Recommendations are given for mold tolerances for various plastics and for general categories of shapes.

Applications

Thermally conductive cast-resin compounds for heat dissipation. C. A. Harper. Electro-Technology *67*, 148-52 (Apr. 1961). High thermal conductive embedment and potting compounds can be used in electronic packaging applications to provide effective heat dissipation, minimizing the need for heat sinks or forced cooling. Properties and effects of various fillers that contribute to thermal conductivity are discussed.

An architect looks at bonding agents for interior surfaces. J. H. Graham. Adhesives Age *4*, 40-41 (May 1961). Describes use of adhesives in bonding plaster finish coats to substrates.

Which hose in high-pressure systems? J. Lozzi. Product Eng. *32*, 70-71 (Feb. 20, 1961). Criteria for selecting among rubber, fluorocarbon plastic, and metal for hoses are given.

Properties

Behavior of PVC and polyethylene pipes in burning buildings. M. Friedrich and B. R. Hinrichs. Kunststoffe *51*, 126-32 (Mar. 1961). Laboratory experiments were made using infrared equipment to study the behavior of PVC and polyethylene pipes under the influence of heat and fire. Tests were also made using a two-story house and burning gasoline. Pipes installed over plaster were damaged and partially burnt, but a thin layer of plaster sufficed to prevent destruction under extreme conditions. No incendiary spread could be detected.

Study of the polymerization of thermosetting polymers by electrical resistivity techniques. R. W. Warfield and M. C. Petree. SPE Trans. *1*, 3-8 (Jan. 1961). The degree of cure of thermosetting polymers is measured by electrical resistivity techniques which are described in detail. The rates of cure of polyester, epoxy, and urethane resins were measured. Activation energies for polymerization and electrical conduction, and second order transitions may be obtained.

Testing

Identification and quantitative determination of natural and manufactured fibers. S. S. Praeger. Mat. Res. & Standards *1*, 381-85 (May 1961). Methods for identifying and determining cotton, rayon, cellulose acetate, nylon, polyester, polyvinyl chloride, saran, acrylonitrile, protein, and animal fibers are given. These include fluorescence, microscopy, elemental analysis, chemical spot tests, burning characteristics, moisture absorption, and effect of solvents.

Absorption spectrophotometry of samples of low transparency. J. Braunbeck. Angew. Chem. *72*, 31-33 (Jan. 1960). By weakening the ray of comparison, it is possible to adapt two-ray spectrophotometers for the investigation of samples of low transparency. Paper, fabrics, and polystyrene foils are used as examples.

Publishers' addresses

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Angewandte Chemie: Ziegelhauser Landstr. 35, Heidelberg 17A, Germany.
Electro-Technology: C-M Technical Publications Corp., 205 E. 42nd St., New York 17.
Kunststoffe: Karl Hanser Verlag, Leonard-Eck-Str. 7, Munich 27, Germany.
Materials Research and Standards: American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.
Modern Packaging: 770 Lexington Ave., New York 21, N. Y.
Plastics Institute Transactions & Journal: The Plastics Institute, 6 Mandeville Pl., London W1, England.
Product Engineering: McGraw-Hill Publishing Co., 330 W. 42nd St., New York 36, N. Y.
Space/Aeronautics: Conover-Mast Publications Inc., 205 E. 42nd St., New York 17, N. Y.
SPE Transactions: Society of Plastics Engineers Inc., 65 Prospect St., Stamford, Conn.
Vysokomolekuliarnye Soedinenlia: Academy of Science of U.S.S.R., Moscow, Russia.—End

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Investigate the advantages of using POLYLITE foam resins in your applications. RCI supplies the complete "package"—including systems for densities from 1¼ to 30 lbs. per cubic foot. Write for details.

REICHHOLD

REICHHOLD CHEMICALS, INC., RCI BUILDING, WHITE PLAINS, N.Y.

U.S. PLASTICS PATENTS

Copies of these patents are available from the U. S. Patent Office, Washington, D. C., at 25¢ each.

U.S. Pats., Apr. 18, 1961

Ion-exchange. R. A. Mock, R. C. Calkins, and C. A. Marshall (to Dow). 2,980,607.

Quaternary ammonium compounds of polyvinyl ethers. S. Melamed (to Rohm & Haas). 2,980,634.

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Polyolefins. G. C. Newland and J. W. Tamblyn (to Eastman). 2,980,645.

Stabilized polyethylene. G. R. Lappin (to Eastman Kodak). 2,980,646-7-8.

Polyureylenes. J. Farago (to Du Pont). 2,980,651.

Copolymers of unsaturated N-(omega aminoalkyl)-1,3-cyclodiazolidin-2-ones. S. Melamed and L. C. Souder (to Rohm & Haas). 2,980,652.

Low-molecular-weight olefin-maleic anhydride copolymers. J. H. Johnson (to Monsanto). 2,980,653.

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Quaternary ammonium acrylamido polymers. S. Melamed (to Rohm & Haas). 2,980,657.

Alkyl methacrylate-alpha-acyloxystyrene copolymers. G. E. Ham (to J. T. Baker). 2,980,658.

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Irradiated polyethylene. A. Brasch (to Electronized Chemicals). 2,981,668.

Cellular polyurethane resins. E. E. Parker and K. H. Coultrap (to Pittsburgh Plate Glass). 2,981,700.

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Polyester molding composition. J. S. Hanson (to Fairbanks). 2,981,713.

Polyamides. V. R. Ben (to Du Pont). 2,981,715.

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Polyurethanes. C. Mühlhausen and K. Genski (to Bayer). 2,981,719.

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Tubular structures. G. F. D'Alelio (to Dal Mon Research). 2,982,457.

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Styrenated oil-modified alkyds. W. F. Hart (to American Cyanamid). 2,-982,746.

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Rosin acid-dialkanol amine condensates. H. A. Cyba and R. B. Thompson (to Universal Oil). 2,982,750.

Polyepoxide-polyamine composition. H. L. Anthes (to Du Pont). 2,982,-751.

Polyepoxide-divinylbenzene dioxide resin. B. Phillips, C. W. McGary, and C. T. Patrick Jr. (to Union Carbide). 2,982,752.

Polyacrylonitrile. R. R. Holmes and L. T. Jenkins (to Chemstrand). 2,-982,753.

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Styrenyl organosilicon polymers. D. W. Lewis (to Westinghouse). 2,982,-757.

U.S. Pats., May 9, 1961

Graft polymers. J. Gabilly and M. Jobard (to Saint-Gobain). 2,983,657.

Expandable polymer particles. G. F. D'Alelio (to Koppers). 2,983,692.

Siloxane elastomers. N. Page and J. T. Lewis (to Midland Silicones). 2,983,-694.

Polyesters. G. Wetroff and I. Raitzyn (to Pechiney). 2,983,695.

Copolymeric vinyl composition. S. Tocker (to Du Pont). 2,983,696.

Polysiloxane elastomers. E. D. Brown and M. J. Hunter (to Dow Corning). 2,983,697.

Oxidized hydrocarbon polymer films. M. A. Tucker and O. C. Slotterbeck (to Esso). 2,983,698.

Polyamide-organosiloxane resin. A. J. Rohm (to Westinghouse). 2,983,700.

Polycondensates of a quinone and a phenol. D. Tanner (to Du Pont). 2,-983,701.

Polyurethane elastomer. J. R. Little and W. P. Whelan (to U.S. Rubber). 2,983,702.

Epoxyalkyl allylarylethers. G. F. D'Alelio (to Koppers). 2,983,703.

Chlorinated elastomers. F. P. Baldwin, R. M. Thomas, and I. Kuntz (to Esso). 2,983,705-6-7.

Polyesters. G. R. Lappin (to Eastman). 2,983,708.

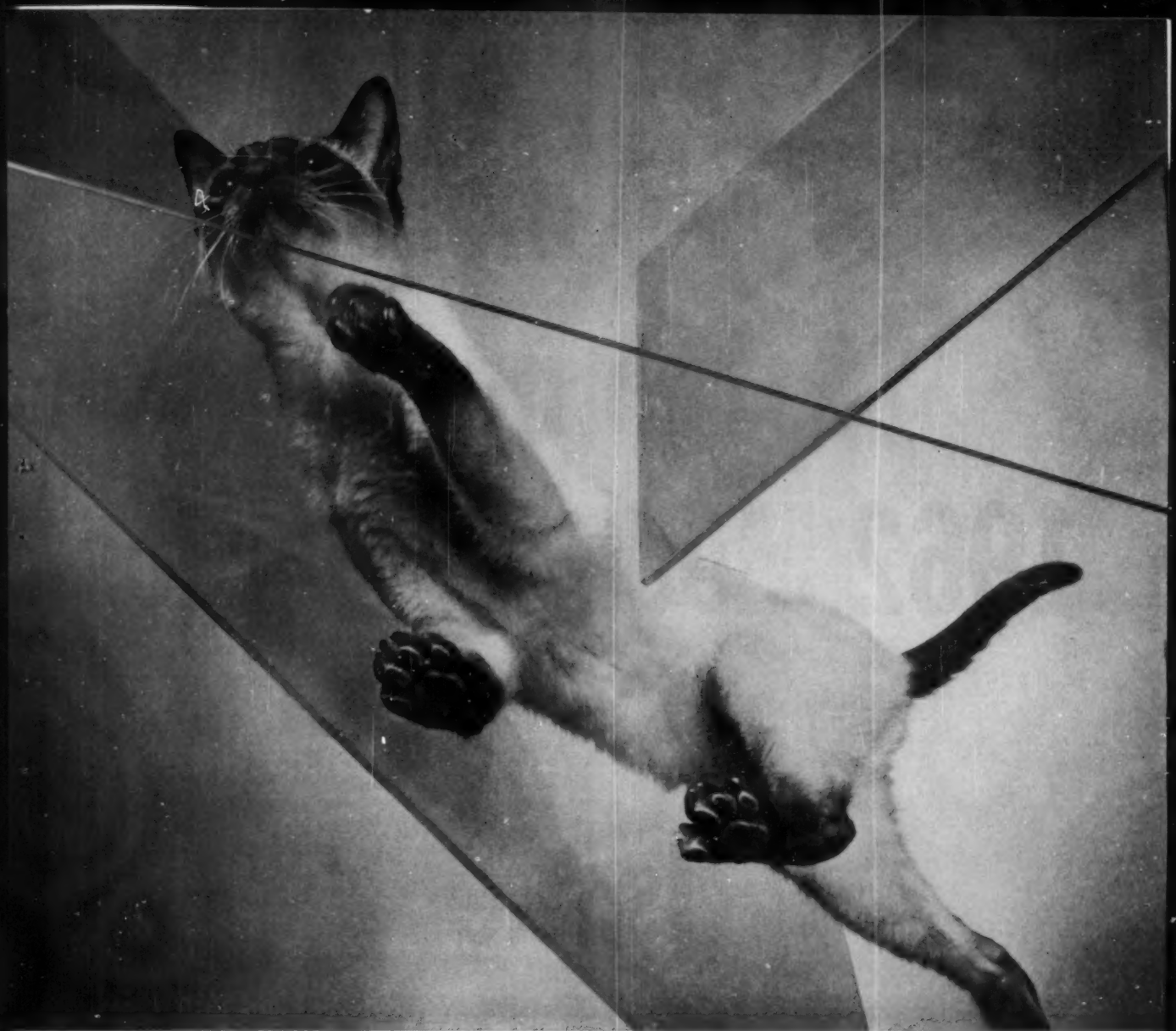
Polyolefins. G. C. Newland and J. W. Tamblyn (to Eastman). 2,983,709-10.

Fluorosilanes. A. F. Gordon (to Dow). 2,983,711.

Polyacrylonitrile. W. K. Wilkinson (to Du Pont). 2,983,712.

Cross-linked ethylene-propylene copolymers. A. E. Robinson and W. D. Willis (to Hercules). 2,983,714.

Water-soluble polymers. E. J. Henley and R. C. Bell (to American Cyanamid). 2,983,717.—**End**



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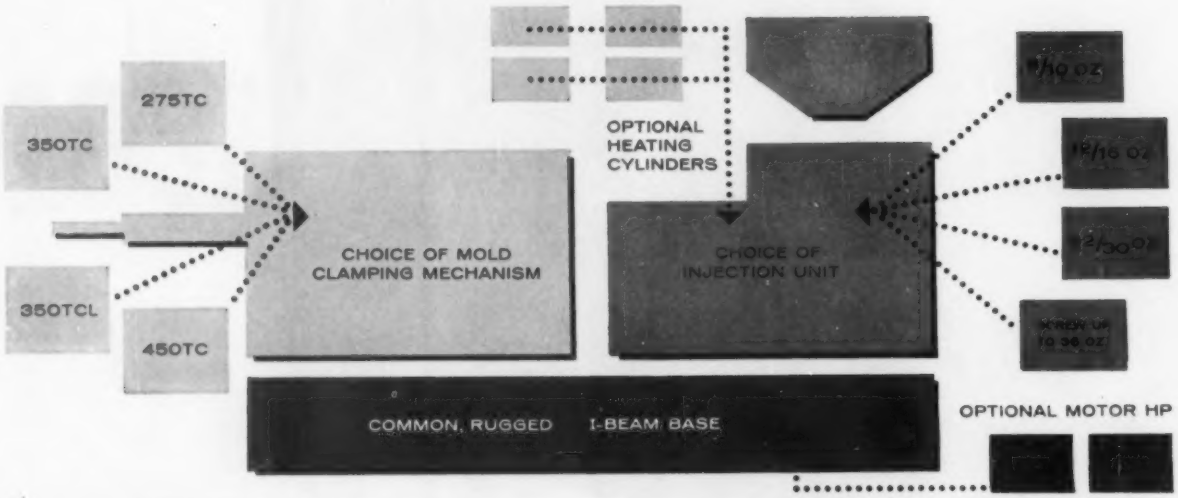

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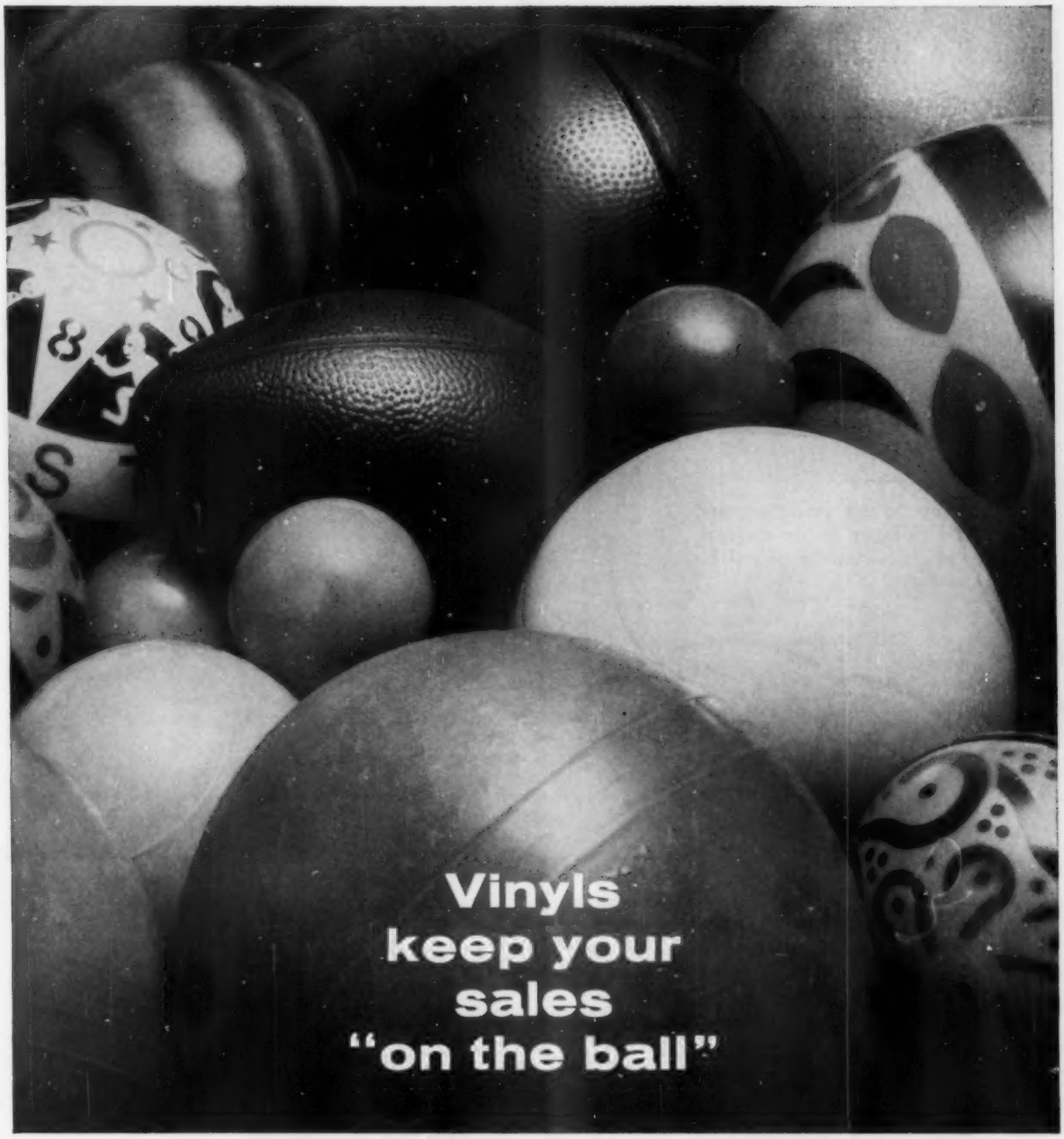

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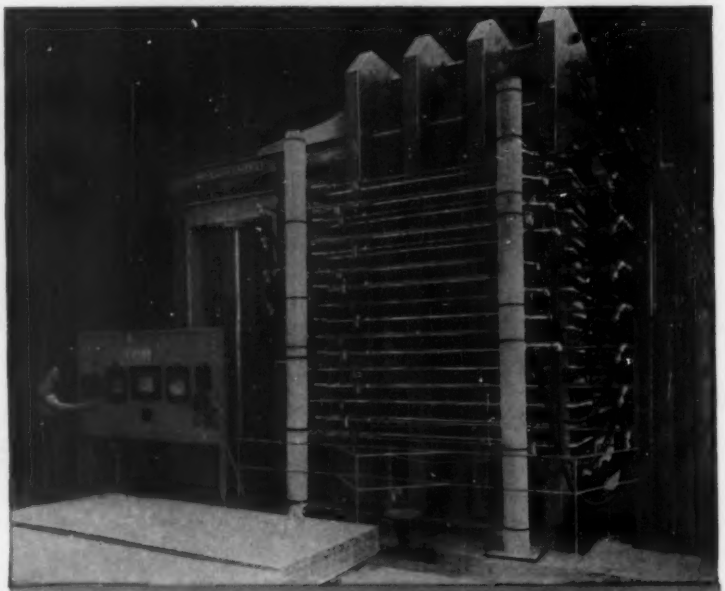

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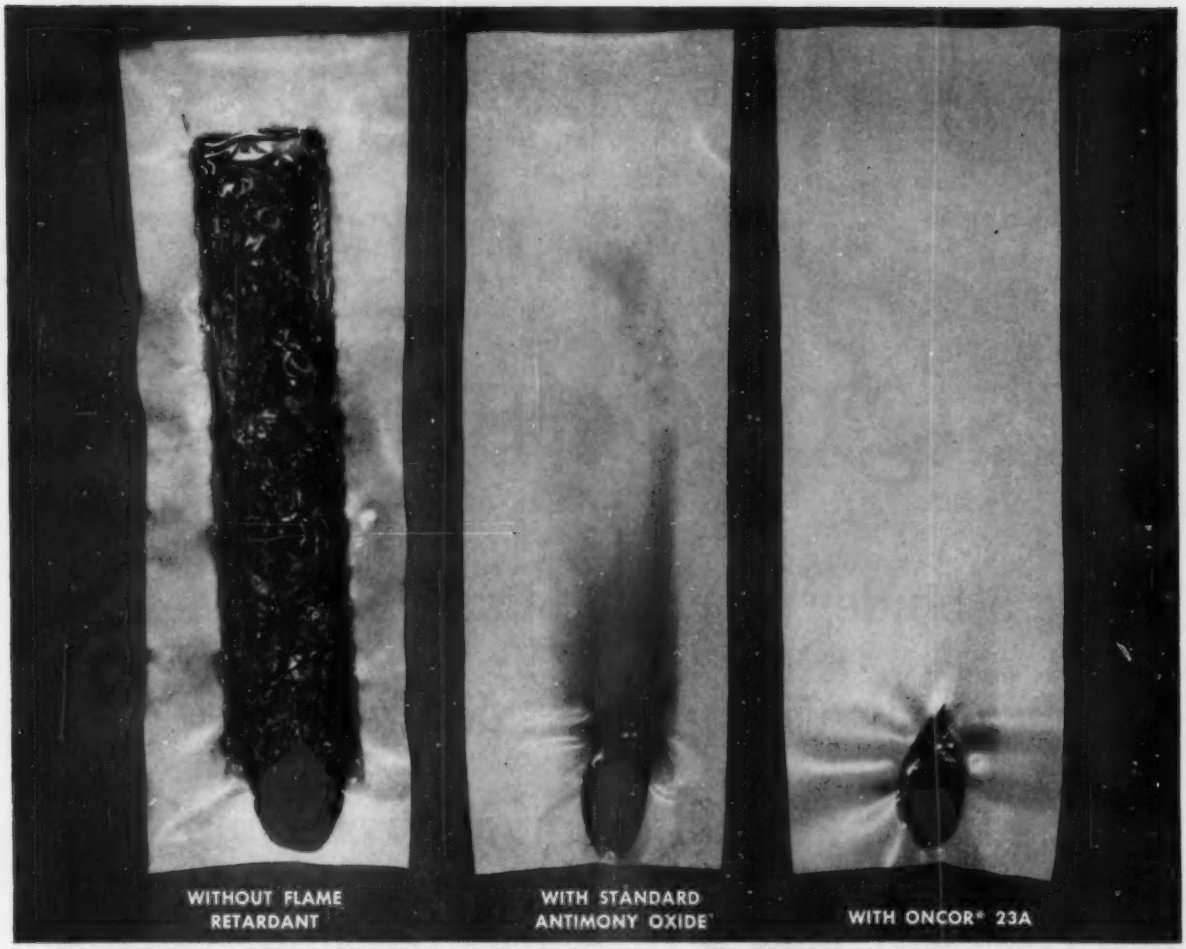

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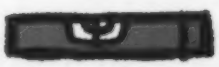
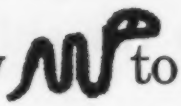
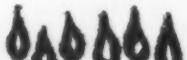
Using a binder especially formulated for this application, Johns-Manville Gun Roving has chemically-controlled chopping characteristics. It is static-free, chops cleanly, and lays down  evenly without clumping. It conforms readily  to sharp radii and intricate shapes because it is soft, not stiff and wiry like other products of this type. It wets out  quickly with

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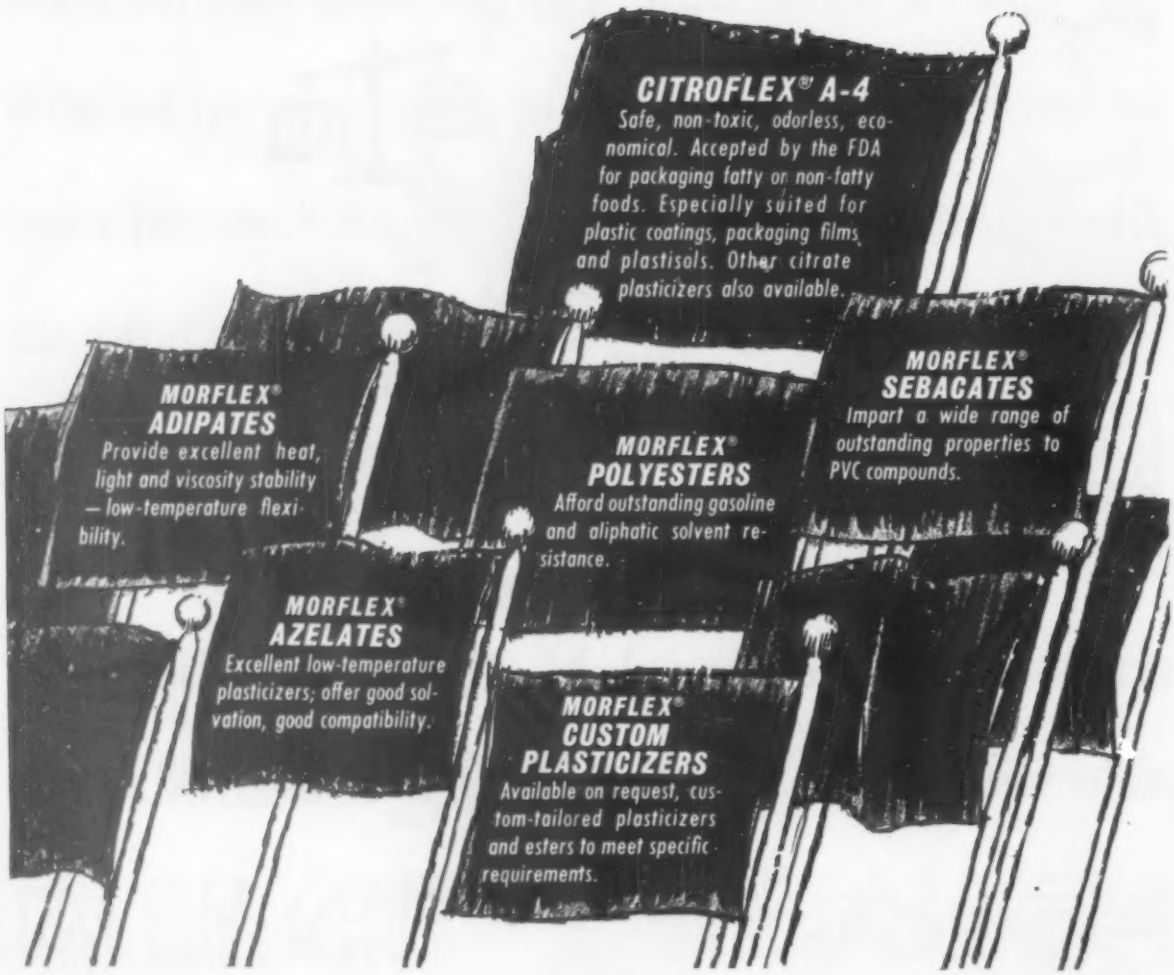
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MODERN PLASTICS

August 1961 Volume 38, Number 12

New concept in international service

Within the past year two important new laboratories for plastics research, development, and service have been established in Geneva, Switzerland. One is owned by Du Pont International Co., the other by Union Carbide International Co.

One purpose of both these laboratories is to help develop new markets for plastics in Europe by rendering technical, testing, design, and costing assistance to customers. If some problems are too complicated for the facilities in Switzerland they may be referred to the companies' larger main laboratories at Chestnut Run and Bound Brook, respectively. And where export and import technicalities and legalities are involved, such as food and drug laws, building codes, and standards, both companies have other laboratories around the world to help solve the problems.

There are other important purposes.

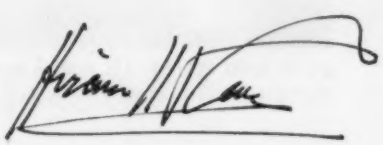
First, European-educated technical and sales people will be available to the companies, their training to be augmented by programmed courses in materials, methods, and marketing at head offices in the United States.

Second, a speed-up in direct communications is expected to make immediately available for the use of the plastics industry on both continents new machine concepts, new design ideas, and new methods of processing developed in the United States, in Europe, or elsewhere, thus cutting down on trial-and-error, and on lead time to production.

Third, market developments in one part of the world may more readily be translated and adapted to the needs of other countries, climates, and standards of living.

Fourth, this world-wide industry, like other industries, has a duty to the new and underdeveloped nations, a duty to organize for the proper use of plastics to the end that standards of living may be improved, that gainful employment may be established, and that natural resources may be efficiently used. Since all the developed industrial nations can contribute to this purpose, the international aspects of technical and marketing advances grow ever more important. The literature is no longer in few languages.

Certainly in plastics, on the speed-up of precise know-how the world over will depend much of our future growth. International technical sales service can be a big factor in producing this acceleration.



POLYPROPYLENE:

These may be the

Polypropylene has probably aroused more curiosity and a hankering for knowledge in the plastics, textile, and rubber industries than any other new plastic material introduced during the last six or seven years. Linear polyethylene, acetals, and polycarbonates have contributed their share of curiosity during this period, but hardly in such a broad area as polypropylene (PP), aptly described as a low-cost product with properties that class it with high-price plastics.

There are many reasons for this curiosity. In the first place there is a great difference of opinion concerning its potentials. Theoretically at least it is an eventually low-cost material and *price* is the most important property that large-volume plastics have to offer. This, in itself, should warn investment bankers and potential producers not yet involved that the present price spread between monomer and polymer will not always remain so wide—the lessons learned in vinyl chloride, polystyrene, and polyethylene should serve as reminders. Furthermore, the monomer cost is a far less important factor in the production cost of PP than it is in many other plastics, except that it must be low or there would be little reason for even attempting to make PP.

Other reasons for curiosity over PP include: 1) several unusual properties such as its heat resistance—higher than other large volume thermoplastics—its stiffness, and its remarkable flex strength which seems paradoxical but isn't; 2) uncertainty about the potential depth of its penetration into various markets including those of materials other than plastics; and 3) the fact that it is the

Photo, Eastman Chemical

FILM AND SHEET: 150 million pounds. (One producer's estimates; see table, p. 75).

Photo, Montecatini

INJECTION MOLDING: 150 million lb. (shown here an auto tail light housing from Italy).

where is it going?

first of a new series of stereospecific polymers which present a wide vista of new thought and new possibilities for synthetics.

It is wise to point out right here that in discussing potential production capacity and market volume there will be scarcely a figure in this article that is not open to disagreement or challenge. After four or five years of intensive market research there are scarcely two people in the industry who will agree on any given set of estimates.

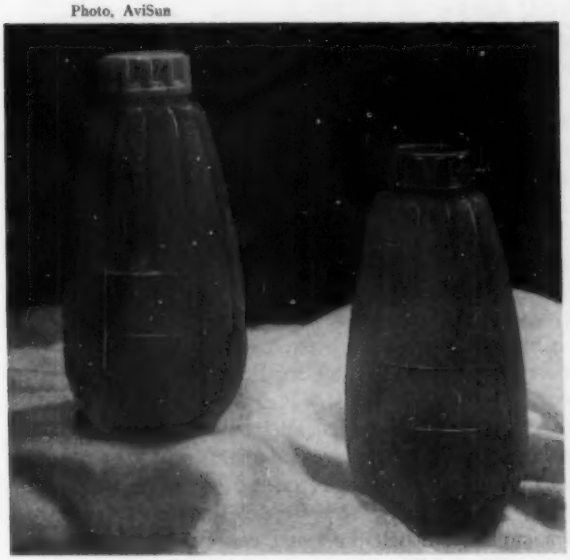
PP's tailored properties

To an ordinary person the reason why properties of a stereospecific plastic are different from those of any other plastic is rather vague and obscure. However, chemists claim it gives the industry a chance to tailor a polymer—to build it up to desired properties. Of course, the industry has been talking about tailoring plastics to given needs of end products for years, and polystyrenes, polyethylenes, vinyls, nylon, and phenolics are certainly well-tailored by now. But the chemists claim that stereospecific chemistry goes much further with more impressive results.

The important aspect is, however, that PP is a new plastic material with several properties that are different from others and the processor must learn how to handle it just as he does every new plastic. Despite the widespread claim that it can be tailored to meet most any eventuality, it is no miracle material, one that

big four markets for PP by 1965

Photo, AviSun



BLOW MOLDING: 20 million lb. (here an olive oil bottle from Spain).

Photo, Hercules

MONOFILAMENTS: 40 million lb. (here bristles, rope and scouring pads made in U.S.)

can be used for any purpose whatsoever. It must be handled carefully and intelligently. It has limitations and flaws that must be overcome by research, design, and processing just as any other resin. This is why PP is not going to become a billion-lb. plastic overnight.

Price—past, present, and future

Among the important factors that will help determine how fast polypropylene may grow is price. Its per-pound price history in the United States is as follows:

Period	*Natural*	*Color*
Dec. 1957 to May 1958	65¢	
May 1958 to Sept. 1958	56¢	65¢
Sept. 1958 to Jan. 1959	49¢	58¢
Jan. 1959 to	42¢	51¢

The 42¢/lb. price has held for a surprisingly long time. Trying to guess when and how much it will decline is like trying to pick out the best-looking woman on earth. The polymer sells at 29¢ in Italy today, but comparison of prices in Europe and the U. S. is like counting potatoes with apples. If consumption fails to grow at a rate commensurate with capacity a price drop could be expected. For example, if the present rate of consumption of something over 60 million lb./year doesn't increase when capacity becomes 200 or 300 million lb. the price will crack, and substantially, too.

Perhaps one reason the price has remained at 42¢ so long is that some producers are not yet satisfied with the quality of their resin in various applications and have not yet fully pressurized their sales programs. The recent AviSun price reduction for its less-than-1-mil-thick PP film, which makes it competitive with thicker PE film for bread wraps on a yield basis, is indicative of what may happen when producers go after specific markets. A similar instance occurred when Hercules reduced the price of linear PE when it went after the bleach bottle business. Just let the customers prove that they can use several million lb. of PP at a few cents per pound less for a given application and prices should begin to crackle.

Potentially PP is a low-cost thermoplastic comparable to linear and even conventional PE, but the time when these three resins may have no more than a 5¢ spread depends on how markets develop.

If a few more good applications like the luggage case and TV set back are developed to promote consumption they could help consume PP surpluses, or if film should suddenly take over in a big way the spread between production and consumption might be lessened and thus help hold prices up. The industry is also trying mightily to move PP into applications not now employing plastics, but this is a comparatively long-haul operation and may not have a big effect on volume until the industry is well loaded with extra capacity. Much the same can be said for fabrics. Most of PP's competition for applications in the next year or so is going to come from other

What is polypropylene?

Polypropylene, as made commercially today, is a stereospecific plastic. As defined, the word stereospecific implies a specific or definite order of arrangement of the molecules in space. Chemists have learned to do this with some monomers by use of stereospecific catalysts in a low-pressure polymerization system. This ordered regularity of the molecules in contrast to the branched or random arrangement found in other plastics permits close packing of the molecule and leads to high crystallinity that gives desirable strength and stiffness characteristics. High-density, low-pressure PE also has close packing of the molecules and high crystallinity but the behavior of the two resins is quite different: PE is subject to stress cracking except in high molecular weight or modified form but PP is not likely to stress crack, except under unusually long exposure.

The word "isotactic" which is used so many times in discussing PP, was coined by Prof. Giulio Natta of the Polytechnic Institute of Milan, Italy, and consultant to Montecatini. He coined the word from the Greek "isos" meaning the same, and "tato" meaning a regular order. Thus, isotactic means a chain of monomeric molecules having the same steric structure with identical structural side groups arranged along the same side of the chain. But the polymer may also contain a portion of what he called atactic structure or "no form," i. e., amorphous material. All producers aim to hold down this atactic content, a sticky gummy substance, but some admit it is large enough so that they are trying to find a use for it besides burning.

At least one American producer claims its atactic content in the original polymer is only 3 to 5 percent. All American producers use the word "isotactic" sparingly in reference to their own PP. In the first place it is closely associated with Montecatini—almost like a trademark; in the second place, many Americans were working on PP development when Montecatini announced its entry into the field and do not necessarily obtain exactly the same structural formation; thirdly, a scrambled patent situation makes it inappropriate to mention details that might affect a company's position in the U. S. Patent Department's study of the subject.

plastics and that situation could hurry a price decline. But one thing is certain: producers have spent millions of dollars in facilities and development work and will have to spend a lot more. Consequently, they may well resist a severe price break to help recoup their heavy investments.

As mentioned before, 4 or 5¢ monomer is a lesser factor in polyolefins production than in other thermoplastics. The reason becomes plain to anyone who visits a polymer plant and sees the high-pressure equipment or refining apparatus necessary for the operation. The PP molecule has a sort of "fluffy" structure that helps to make it the lightest commercial plastic available. It is in the 0.900 to 0.910 range, compared with PE at from 0.912 to 0.970 (for molding and extrusion). Polystyrene is about 1.05. The difference in density between PS and conventional PE means that there would have to be around 3¢ difference in price before they would be equal on a volume basis. The difference between PP and PE would be somewhere around 2¢/pound. Roughly speaking a 29¢/lb. PP would give about the same cost-per-unit yield as a 27¢ PE.

Who makes it—and how much?

Producers (as of 1/1/'63)	Millions of lb.*
Allied Chemical	10
AviSun[a]	100
Dow Chemical[b]	30
Firestone	10
Hercules	120
Humble Oil[c]	60
Novamont (Montecatini)	32
Shell Chemical	80
Texas-Eastman	25
Total	467

[a] Represents minimum at new New Castle, Del., plant—could be much more. Twenty-five-million-lb. operation at Port Reading, N. J., in Koppers plant not included—may be turned back—no decision as yet.
[b] A hazy guess. Dow has several low-pressure plants that may be used for either high-density polyethylene or polypropylene, depending upon demand.
[c] Humble is currently operating a 40-million-lb. plant near Houston, will go to 60 million soon, and to 100 million just as soon as it is needed.
* The above estimates are subject to quick change in both timing and volume. Every company here is prepared for rapid expansion and there are 8 or 10 more who could be in production by 1965 when capacity may be well over 500 million pounds. See page 145 ff. for estimates concerning each company's position.

Stabilizers vary by application

Among the uncertainties affecting PP when it was first introduced was the matter of stabilization. All polyolefins are subject to oxidation or degradation of properties unless properly stabilized, but PP is perhaps a little more so. The problems of stabilization are many and diverse—the competition between companies to produce the most efficiently stabilized PP is likely to show up in their advertising for a long time.

The danger of oxidation in PP is due to its inherent molecular configuration which makes part of the molecule more subject to oxidation than other plastics. Oxidation, in essence, is burning; actual fire is the most rapid form of oxidation, but of course, there are slower, non-flaming forms, *e.g.*, rusting of iron. Similarly, a pan of water will evaporate but it evaporates faster if boiled. When PP is subjected to high temperature, as it is in many applications, it oxidizes rapidly unless stabilized. There is no one stabilizer system. Companies have already each developed a half-dozen or more systems for resins designed for different

PP markets[a]—how will they develop through 1965?

	in millions of lb.						
	1959	1960	1961	1962	1963	1964	1965
Film and sheet[b]	0.5	2.0	10	25	45	100	150
Injection molding	10.0	15.0	25	38	75	100	150
Wire and cable	0.0	0.0	1	5	8	15	25
Coating	0.0	0.0	1	3	5	10	15
Blow molding	0.0	0.0	2	5	10	15	20
Pipe	0.5	1.0	2	4	5	10	10
Monofilament	0.0	9.0	15	25	40	40	40
Multifilament	0.0	1.0	5	20	30	60	100
Miscellaneous	5.0	6.0	12	15	18	20	25
Total	16.0	34.0	73	140	236	370	535
Export	0.0	2.0	4	7	10	15	20

[a] Above estimates were provided by a producer.
[b] Film figures for '64 and '65 are compromises. If polypropylene is successful in potential markets the total here could be between 200 and 300 million lb. However, the market may develop at a rate slower than given here, with consequent smaller volume in these years.

applications and are still trying for many more.

The first big issue was to stabilize to withstand processing heat. The next major need was heat resistance that would withstand temperatures well over the boiling point in service. Hospitalware which requires repeated half-hour sterilization was a first in this category. This development gave rise to heat-resistant resins especially useful for television backs, electrical components, and dip tubes. The result is that PP now has the highest heat resistance of any volume thermoplastic when properly stabilized. One company asserts it has a stabilizer system which would withstand oven aging at 300° F. for 80 days. Even products made from the food-grade resin can be boiled indefinitely and the stabilizers used here are chosen primarily for lack of toxicity rather than stabilizing efficiency.

But PP stabilized for heat resistance either in processing or use is often not suitable for applications requiring a high degree of other characteristics. If the customer wants heat resistance he may have to sacrifice other properties.

Resistance to sunlight is still a question mark as it pertains to PP stabilization with general agreement that it is not now as well-controlled as heat stabilization. Ultra-violet inhibitors can be used for outdoor applications but long-term performance is still uncertain. Of course, carbon black is so far the best inhibitor and color pigments are helpful, but there is no unanimous opinion on the effectiveness of light controls. The amount of control needed varies from one application to another. For example, a PP part in an automobile gets a good amount of screening from light rays and, therefore, may require less stabilization. But there is simply not enough experience to tell how well PP will perform in actual use. Yet the one thing that probably dramatized light stabilization more than any other was the Hercules introduction in 1959 of a PP resin for monofilament which made PP a qualified contender for markets in auto fabric, outdoor furniture webbing, and rope.

In addition to the stabilizers described above there are stabilization and additive systems needed to prevent oil or water extraction, instill fire retardance and anti-static properties, and counter other problems. A separate system for almost every end use seems a necessity. This is not new in plastics, as witness the vinyl industry.

However, the stabilizer situation in PP is even more critical than these other plastics. This leads to complex problems that may be alleviated as experience is gained, but a producer who changes a customer's formulation to meet the latter's request may also have to change the stabilizer system. This leads to various production problems that not only worry the technicians but also cost a lot of money.

Another important factor in polypropylene is that the molecule is long in length compared to its diameter. This permits molecules to be "lined up" to develop high strength. **(To page 140)**

How much PP will be produced abroad?[a]

	Original start-up	*MM lb.*
Japan		
Mitsui Toyo Rayen	1962	22
Mitsubishi-Petrochemical-Mitsubishi Rayen	1962	22
Sumitano Chemical Toyo Spinning	1962	22
Tokuyama Soda-Idemitsu Kosan	1961	4.4
Shell (PE or PP)	?	33
Germany		
Farbwerke Hoechst	1957	59.4
Hüls	1960	6.6 to 13.2
Farbwerke Hoechst	1962	44
	1965	88
Hüls	1962	13.2
	1965	26.4
United Kingdom		
ICI	1960	24.2
	1962	28.4
Shell	1961	24.2 to 30.8
Netherlands		
Shell/Montecatini	?	22
France		
Pechiney (Naphtachemie)	1961	11 to 22
La Societe Normande Plastique	1961	13.2 to 22
Italy		
Montecatini (in Ferrara)	1957	11
		15.4
	1961	61.6
Montecatini (in Brindizi)	1960	61.6
Montecatini (in Terni)	1961	22
Austria		
Danubia Petrochemie, Schwecht (ownership 40/40/20 Stickstoffwerke-Montecatini-Austrian Government)	1960	11
Danubia Chemical Company	1961	15.4
Sweden		
Svenska Esso	Dec. 1963	15.4
Canada		
Dow (in Sarnia)	?	?

[a] Current and future foreign production capacity estimated by one U. S. producer.

Photos, Micarta Div., Westinghouse Electric Corp.

CORROSION-RESISTANT BLADES for water-cooling fan at oil refinery are made from graduated layers of phenolic laminate. Fabrication method prevents sagging of blade ends under load of damp air by equalizing load throughout entire blade.

For large industrial fan blades:

No-sag design in phenolic laminate

One widely recognized advantage of plastics materials is the great flexibility of design which their use affords. And probably nowhere is this flexibility brought home more dramatically than in those instances when changing conditions and circumstances bring about a need for an immediate and economic re-design of a part in order to extend its range of application.

A case in point: blades for induced-draft fans used atop water towers to cool recirculated process water. Such fans are widely used in chemical plants, oil refineries, and utility stations. Corrosion of steel blades, once a major problem, had originally been licked by a changeover to blades molded of laminated phenolic. Such blades gave excellent anti-corrosive service—when used on fans of diameters ranging from 7 to 14 feet. But when the phenolic design was extended to blades of larger size—for horizontally-rotating fans of 14- to 22-ft. diameter—a new problem arose which threatened the feasibility of the application.

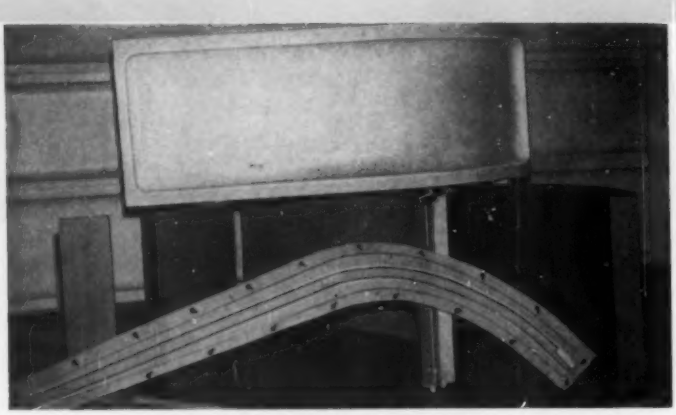
The original design called for a fan blade of uniform thickness along its entire length. For fans up to 14 ft., these blades had enough inherent strength to carry a double burden—their own weight, supported only at the hub of the fan, and the additional load of damp air they were forcing up out of the cooling towers. However, beyond this length the blades would sag at their tips, sometimes striking supporting structures and damaging both tower and blades.

What was needed, of course, was a more efficient distribution of strength **(To page 155)**

SEMI-FINISHED BLADES consist of multiple layers of adhesive-coated laminate, joined together under steam and pressure of forming die. Workman is bolting blade shank to blade body. Square end of shank will be machined into final round shape; stepped-down laminate surface will be ground to smooth finish.

Versatile partnership:

THE COMBINATION of reinforced plastics skins with urethane foam cores has all the makings of an ideal material of construction—outstanding strength, built-in insulation, moisture resistance, ease of application, and over-all utility. The approaches to utilizing the combination, however, from the standpoint of production economies have already taken many directions. Illustrating this diversity in approach are three of the



COMPLETED PANEL for experimental shelter has hard RP inner and outer skins with foamed-in-place urethane core. Panel is shown resting atop mold (center) and (to left and right) master model from which mold was made.

SPRAY-UP technique was used to form RP skin on inside surfaces of mold. First a wax parting compound was put on mold surface, then a coat of resin and chopped fibrous glass, then a layer of dry chopped fibers to form a shaggy coat for greater adherence to foam.

U. S. Army shelter

By S. B. Swenson* and J. MacClarence*

Fabrication technique: Spray-up of resin-impregnated chopped fibrous glass to form skin, followed by spray-up of interior layer of dry chopped glass to assure firm bond with foamed-in-place urethane core.

IN ITS continuing program to develop for the military a semi-permanent, readily transportable, and easily erectible shelter (see also, "Field erection of plastic shelters," MPI, Aug. 1960, p. 113), the Army's Research and Development Laboratories, Fort Belvoir, Va., has taken a new approach. This is a structure made of low-density (2 lb./cu. ft.) polyurethane foam panels surfaced with fibrous glass-resin laminate.

This shelter developed out of an effort to meet the Army's need for an insulated liner inside snow tunnels for use—for both personnel and equipment—at its remote Camp Century in the Arctic. For such use, a shelter should combine the following characteristics:

1. Low cost transportation of components—the camp is 2900 surface miles from New York, 125 miles of which is over trackless wastes. The greatest advantage in the reinforced plastic-polyurethane foam design stems from the savings in shipping cubages resulting from shipping material which is expanded by a factor in excess of 30:1 at the site of use;

2. Reduction in necessary storage space and maintenance of said space at numerous military supply points;

3. Ease of fabrication of components by mili-

*U. S. Army Engineer R&D Laboratories, Fort Belvoir, Va.

reinforced plastics-urethane foam

most recent applications: a military shelter, a ladder, and an ice-cream truck. Each differs from the other in size, shape, and end-use service. And it is testimonial to the flexibility of the reinforced plastic-urethane foam marriage that in each case the particular selection of the fabricating technique used—and each differs from the other—had the same end result: a better product at lower cost.

Photos, U. S. Army

EXPERIMENTAL SHELTER is 24 ft. long, 16 ft. wide, with 9-ft. inside clearance. Materials used were 600 lb. of urethane resin; 150 lb. of polyester resin; and 150 lb. of fibrous glass roving.

tary personnel, after rudimentary training, at or near the final site of the shelters.

The RP-foam shelter being developed by USAERDL is a preliminary step toward meeting these requirements and, in addition, offers promise of obtaining a minimum number of components; low vulnerability to damage during transit both for tools and materials; and relatively low cost, since no expense of a fixed plant for component fabrication, a usual element in prefabricated shelter costs, need be underwritten.

(Ed. note: The RP-foam shelter must still be classified as "under development." But commercial builders may have much to learn from the experiences of the personnel at Fort Belvoir.)

Shelter design

The foam-plastic shelter designed and built at USAERDL is 16 ft. wide by 24 ft. long with an interior clearance of 9 feet. The cross section is in the shape of a modified parabola and consists of one roof panel joined to two side panels. The building was made using four molds; side, roof, end walls and floor, and sills. The panels were cast with interlocking joints and assembled using polyurethane as an adhesive and glass fiber reinforced plastic tabs to lock the joints.

All panels were composed of a 2-lb.-density polyurethane foam core with an approximate $\frac{1}{32}$-in. thick layer of fibrous glass-polyester facing. Both the side and roof panels were 3 ft. wide and approximately 10 ft. long on the periphery. Thickness of the joint sections of the side wall panels varied from 4 in. at the bottom to 8 in. at the spring lines, diminishing to 5 inches. The joint section of the roof arch was a uniform 5 in. in the center sections. With the exception of the joint sections, the center portion of all panels was thinned to 2 inches. On the side walls, the recessed section faced the exterior to maintain a flat in-

terior wall surface. The roof arch was designed with the recessed section on the interior to prevent water pockets from being formed.

As a study, some of the panels were surfaced with a pigmented gel coat, Olive Drab on the exterior and white on the interior surfaces. The remainder of the panels were fabricated with white pigmented resin, eliminating gel coats. The completed side panels weighed approximately 37 lb., of which 15 lb. was the fibrous glass skin. The completed roof panel weighed 38 lb., of which 16 lb. was the fibrous glass skin.

Fabricating the panels

The fabrication of all panels for the shelter was a four-step procedure:

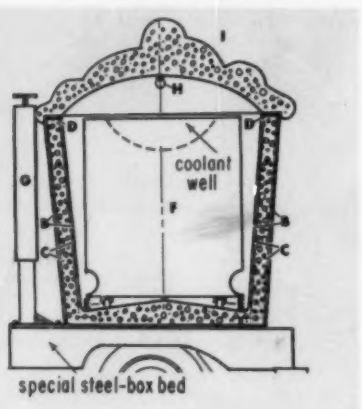
1. The inside surface of the mold was first coated with a wax parting compound (followed with a pigmented gel coat if applicable).

2. The approximate $\frac{1}{32}$-in. layer of chopped fibrous glass laminate was then sprayed over the wet surface coat. The glass chopper was set to cut short fibers, which were sprayed with sufficient resin to give complete wetting without rolling out.

3. An application of dry glass was sprayed from the chopper, producing a shag or mat coat. The resultant surface produces an excellent lock or bond between the laminate and the foam. The average time of application of the fibrous glass for the wall and roof panels was approximately 6 min. each for a two-man crew, or approximately 25 sq. ft. per minute. It was found that the resin-fibrous glass depositor may be used satisfactorily by personnel familiar with paint **(To page 157)**

Mobile ice cream dispenser

Photos, Space Structures



EYE-CATCHING ice cream merchandiser is mounted on back of pick-up truck. Parts labeled in diagram at right are: A) foamed-in-place polyether-type urethane; B) fibrous glass reinforced shells made by combination of hand lay-up and spray-up; C) a 12- to 15-mil gel coat; D) rubber gasket of cover; E) rollers for F) revolving dispensing unit; G) lifting mechanism; H) light; and I) foam-insulated top.

Fabrication technique: Inner and outer shells of RP formed by a combination of spray-up and hand lay-up: polyether urethane insulation foamed in place between shells.

THE REINFORCED PLASTIC-URETHANE FOAM MARRIAGE is already making a strong bid for another field previously dominated by metal.

The field: insulated containers for dispensing pre-packaged food items. In this product area, the overriding reason why the RP-urethane foam concept of construction has taken hold is the tremendous savings in tooling costs as compared with metal construction. This economic advantage is particularly significant in applications where a simple rectangular container design has given way to unusually-shaped container design.

How much money can be saved in tooling costs? As an example, the selection of all-plastic fabrication materials over steel has saved one Midwest company nearly $30,000!

The basic requirement set forth by this company, Mity-Good Vending Co., Omaha, Nebr., was for a combination container and dispenser for its line of pre-packaged ice cream. But in addition, the company desired an unusually-shaped unit—a 6-ft.-high "ice cream sundae"—that could serve as a traveling **(To page 160)**

Safety ladder for electrical work

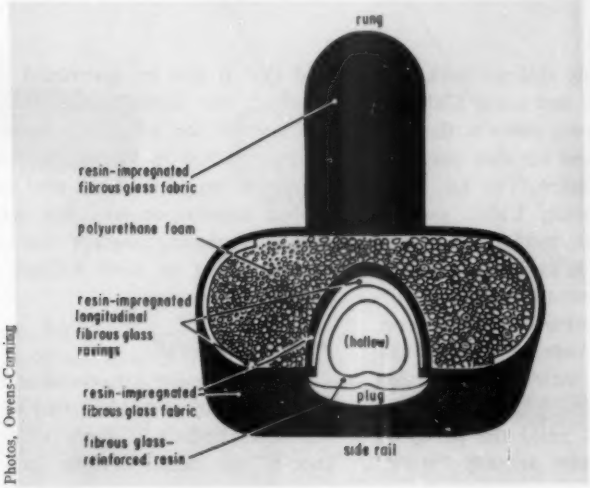
Fabrication technique: Strengthening of foam core with impregnated rovings laid up longitudinally; impregnated glass cloth then wrapped around assembly for added strength and abrasion resistance.

THE REINFORCED PLASTIC-URETHANE FOAM type of construction possesses excellent electrical insulating characteristics as well as inherently high mechanical properties. It is therefore not surprising to note that the material has recently been applied to the manufacture of rugged, nonconductive safety ladders.

The new ladders, developed by American Allsafe Co. Inc., Buffalo, N. Y., are particularly suitable for work around live wires. The complete safety of the ladders during high voltage repair or maintenance operations has been proved by a series of dielectric tests conducted on a 3-rung ladder sample. In the tests, voltages applied to adjacent rungs of the sample went as high as 116 kv. before flashover occurred between the rungs, while about 200 kv. were required to cause flashover between the first and third rungs. Test voltages were also applied to the ends of both side rails, and approximately 290 kv. were required before the appearance of a noticeable flashover.

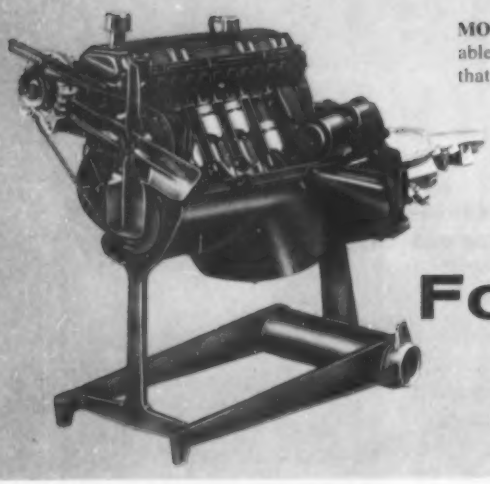
Combinations of reinforced plastic and urethane foam materials are used both for rails and rungs of the new ladders. Side rails consist of urethane foam cores wrapped with polyester resin-impregnated fibrous glass cloth. In addition, resin-impregnated longitudinal glass rovings are laid up on the foam core as reinforcement along the inside and outside working edges of the rails. Up to 72% of glass is used in these spots to provide the maximum possible strength-to-weight ratio. The method of controlling the amounts of glass and resin is said to be identical to that used in making filament wound missile components.

The ladder rungs are also constructed from a combination of polyurethane foam core, longitudinal glass rovings for reinforcement, and wetted glass fabric for an overwrap. Rungs are held in place by compression molded RP plugs, which are bonded to the inner surface by a resin adhesive. Glass fabric wrapped around rails and rungs serves four purposes: it holds the longitudinal rovings in place; **(To page 162)**

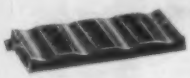


Photos, Owens-Corning

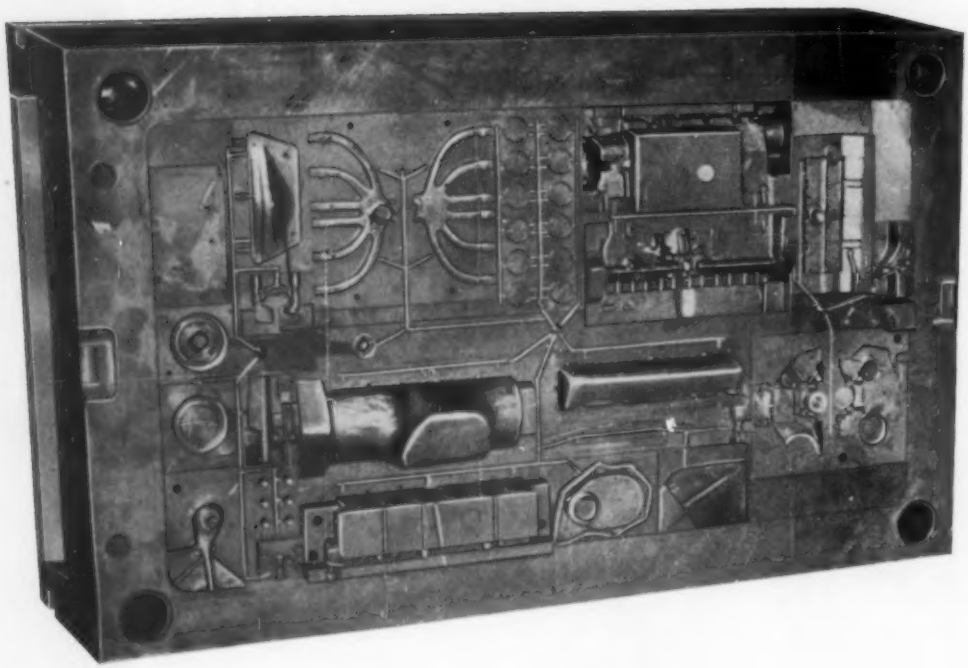
RP-FOAM construction of extension ladder combines rugged strength with safety-providing nonconductivity. Elements and construction techniques used are identified in diagram of cross section of rail and rung.



MODEL ENGINE (left) has removable block and manifold (below) so that working action may be seen.



For ¼-scale model:



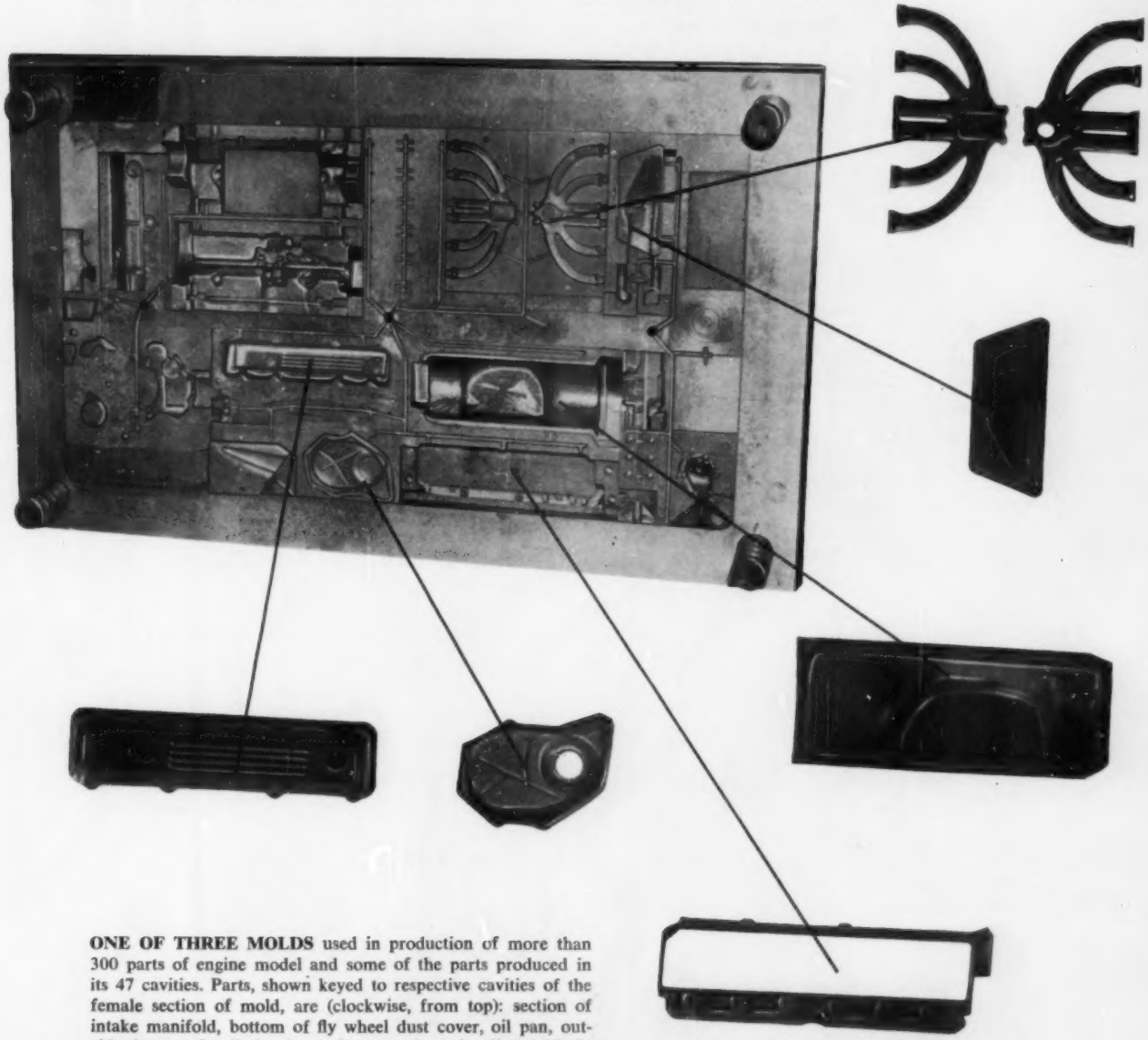
Know-how and engineering ability—backed by nearly two years of research and some $200,000—has added an important new entry to the burgeoning roster of plastic model kits that has revolutionized today's hobby market. The kit, introduced by Revell Inc., Venice, Calif., can be assembled into a quarter-scale model of Chrysler Corp.'s Slant-Six engine. It is authentic in every detail, even down to a molded-in textured surface that simulates the appearance of cast iron. But what really sets it apart from other model kits on the market—and here, incidentally, is also the real testimonial to the design flexibility of the high-impact styrene used to mold the parts—is the fact that its moving parts actually "work" and that it can be assembled and disassembled in much the same manner as the real engine. Because of the advanced engineering principles thus embodied in the kit, its manufacturer sees its use as an educational tool for schools, automobile training centers, and service stations—a radical marketing concept that could give an important boost to sales volume of a variety of similar kits.

A new approach

In most model kits there is rarely a limit to the number of parts that need to be cemented by the model builder. It, therefore, made little difference to the model designer how the parts were

full-scale engineering

Maker of plastic model kits expended years of expensive development time to produce an exact model of a new automobile engine which "works" and can be disassembled and serviced just like the actual prototype



ONE OF THREE MOLDS used in production of more than 300 parts of engine model and some of the parts produced in its 47 cavities. Parts, shown keyed to respective cavities of the female section of mold, are (clockwise, from top): section of intake manifold, bottom of fly wheel dust cover, oil pan, outside frame of cylinder head, front section of cylinder block, and valve cover. Photos, Revell Inc.

divided, as long as they would be cemented together in the final model.

In the design approach to the model kit for the Slant-Six engine, however, a completely different tack had to be taken. Here, the aim was to keep to a minimum the number of parts that required cementing so that the engine could be assembled and re-assembled with the same nuts-and-bolts technique as is used on the real Slant-Six engine itself.

In developing an engine kit, Revell chose to duplicate the Chrysler Slant-Six as "an engineering advance in auto engine design." The engine, of a type formerly used only in high-performance sports and racing cars, was introduced by Chrysler in its 1960 line of compacts. The slant design (cylinders are inclined at 30° from vertical) reduces over-all engine length and allows for improved engine "breathing" through use of long branch intake and exhaust manifolds. These and other design innovations are faithfully reproduced in scale in the plastic model.

Design procedure began with the dis-assembling of the real Chrysler engine. Full-size plaster patterns were cast to be used as masters for the quarter-scale reduction—an operation that consumed some 5000 man-hours. For the removable parts of the engine, the designers came up with a unique molded-in slot that would accept hex-head machine screws and nuts of various lengths to secure the plastics parts in place. To make the model extra sturdy for continued usage, the inside wall sections around these slots are beefed up during molding.

Aluminum and steel cavities for the various parts were then made from the patterns and component parts and half-a-dozen pilot run kits were produced on a die-try machine. These pilot model kits were the testing ground for approaches to be used before entering the final tool and die work stage. During this period, Chrysler engineers worked closely with Revell engineers, checking each step for authenticity, operating features, and sturdiness. Witness to this emphasis on authenticity is the fact that the molds were built to duplicate the rough sand casting texture in addition to providing molded-in serial and identification numbers, and even to simulate forging and casting parting lines.

Production set-up

The three production molds that were eventually created to produce the more than 300 high-impact styrene parts that go into the model required over 13,000 man-hours to build. Weight of the plastics parts involved was around 750 grams. All three molds—one with 47 cavities, the second with 87 cavities, and the third with 176 cavities— were run at a cycle of 90 shots per hr. on 12-oz., three-color Impco injection molding machines. Parts for the kit are produced in black, red, grey, and silver.

Production is estimated at between 12,000 and 15,000 kits per week. As shots are removed from the adjacent battery of molding machines, they are packed in polyethylene bags to prevent loss of parts.

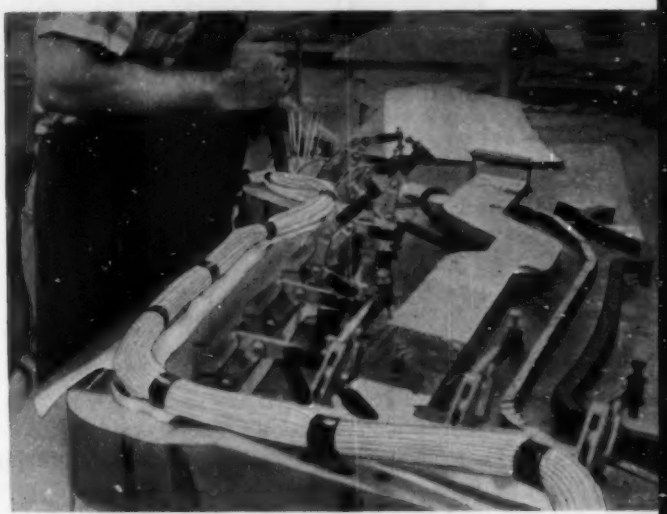
So that the model builder can see all the moving parts, operating in conjunction with one another, Revell has included an electric motor, together with precision reduction gears, so that the model can be operated in "slow motion" to allow the viewer to follow the firing sequence. Light bulbs, operating from the distributor, show firing and timing sequences of the spark plugs, just as in the real engine. If timing sequence is operating incorrectly, as evidenced by watching the lights, adjustments can be made just as they would be made on the actual engine. The Revell model kit retails at $12.95.—**End**

CHRYSLER ENGINEER W. E. Weertman, member of the team that designed the real engine, also aided Revell designers in creating scale model. Mr. Weertman is shown with actual engine displayed with parts (top left) that make up the ¼-scale plastic model.

Prepreg licks tough wiring problem

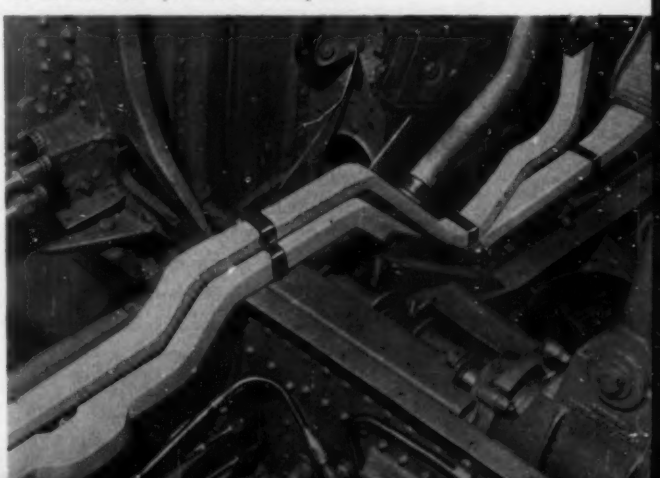
COMPARISON of wire wrapping methods indicates space saving advantage of molded prepreg harness (two sections at right), which carry same number of wires in one-third the space required by flexible harness (left).

Rigid polyester prepreg harness for wiring of fighter plane saves precious space and weight, upgrades electrical performance, and lessens wire damage



WIRE BUNDLE is fitted into bottom of split female mold lined with 3 plies of polyester-impregnated glass cloth. Prepreg will be wrapped over top of the wiring bundle, then cured at 250° F. for 1 hour.

PREPREG HARNESS is molded to conform with structural contours of aircraft interior. Rigid construction resists abrasion and puncturing, prevents wire breaks and possible failure of electrical system in the airplane.

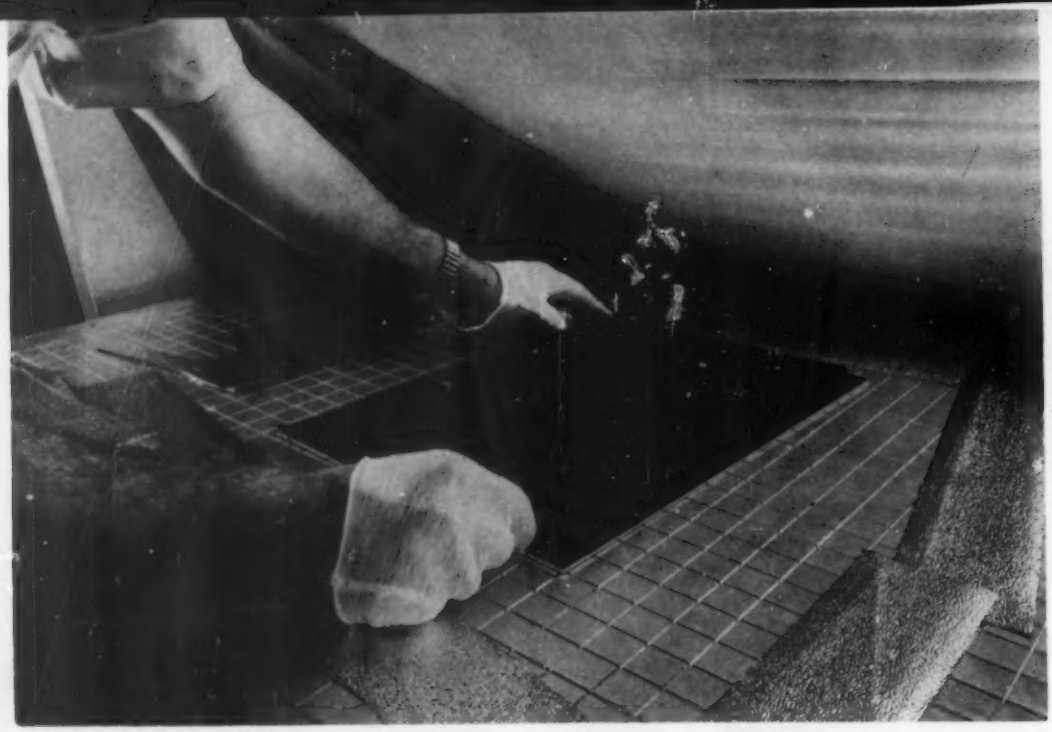


Problem: How to take all of the electrical wiring of a modern jet fighter plane and harness it in a way that reduces bulk and weight, and, at the same time, provides optimum electrical performance in an environment of extreme wear and high heat?

One solution: Bundle the myriad wires together and encase them in rigid harnesses molded from polyester-glass prepreg materials. This is what the builder of the F8U-2N Crusader, the Navy's fastest operational fighter plane, did.

Here are the dividends accruing to the builder from the switch from laced binding of wires to prepreg harnesses:

1. *Space saving.* A conventional 360-wire bundle in a flexible laced harness measures 2⅝ in. in diameter, or if divided into six smaller bundles and harnessed, forms a rectangular unit measuring 3⅜ by 2¼ inches. In contrast, the same number of wires can be carried in a hard, molded prepreg harness measuring just 1½ by 1⅝ inches. In a hard prepreg harness, wires require less outer **(To page 150)**



RIGHT-READING NEGATIVE, emulsion side down, is positioned over unexposed Dycril plate in special exposure frame. Vinyl cover sheet, above, is pulled down by vacuum to make tight contact between negative and plate. Plate is then exposed to carbon arc light for about 7 minutes. Image is completely formed on exposed areas, which have been polymerized.

FOR QUALITY PRINTING—

Best testimonial to the future prospects for a unique type of plastics in the making of printing plates is the fact that Du Pont, who spent more than $6 million to develop the material, has finally announced plans to put up a plant to produce more than 1 million sq. ft. of the basic plate material a year. And from all indications, the company's optimism seems well justified.

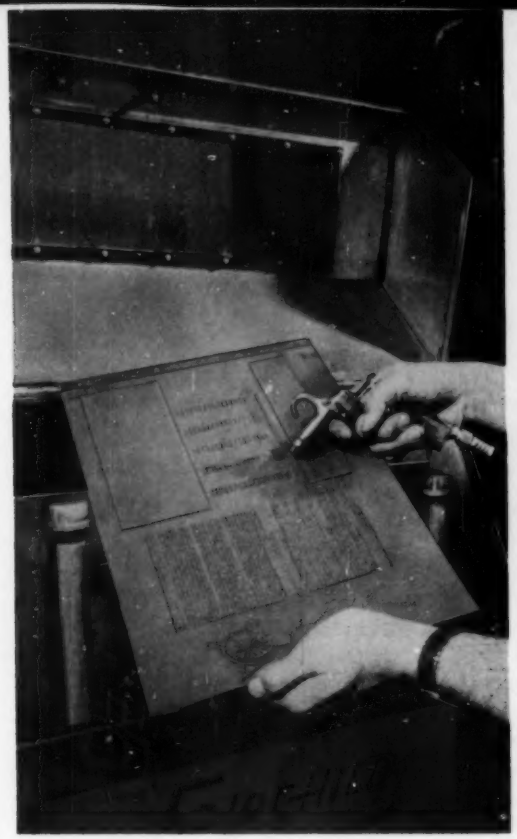
Here's what Du Pont is betting on: a synthetic monomer, known as a photopolymer, that can be polymerized simply by exposure to ultra-violet light. When bonded to a thin layer of metal (aluminum or steel), the material forms the base for making printing plates of exceptionally high quality. The material is tradenamed Dycril.

The plate-making process

The simple procedure for making a letterpress printing plate from Dycril would be about as follows: A negative of the copy to be reproduced is positioned, emulsion side down, on the monomer surface of the raw plate material and the combination is placed in an exposure frame. A sheet of vinyl is then clamped in place over the negative and held down by vacuum to assure positive contact between the negative and the plate. The negative is then exposed to a source rich in ultra-violet light (*e.g.*, a carbon arc) for about 7 minutes. Where the ultra-violet rays strike the monomer surface (through the transparent sections of the negative which, naturally, are the sections of the copy that are to be reproduced), the monomer is polymerized, becoming hard and relatively insoluble. Placed in a solution of less than 1% sodium hydroxide, the unexposed, unpolymerized monomer surface washes away, leaving the polymerized surface in relief—an exact reproduction of the negative.

Essentially, the process differs from conventional photo-engraving techniques in that the plate is produced directly and quickly from the negative. When using standard metal plates, it is first necessary to coat the plate with a "resist"; light passing through the negative hardens this coating in the printing areas of the metal plate, protecting them while the rest of the metal surface is etched away in an acid bath.

By thus eliminating the coating step and the subsequent acid-etching steps from the plate-making process—the very points at which qual-



Photos, Du Pont

FINISHED PLATE, in this case a letterpress type, is locked on patent base and proofed to check fidelity of reproduction.

EXCESS WATER is blown off plate with air hose following washout procedure in which unexposed, unpolymerized plastic is removed from plate leaving exposed areas in relief. Washout cabinet, in background, is equipped with a series of nozzles which spray plate as it is rotated. The solution is water containing less than 1% sodium hydroxide. After drying, plate is ready for press.

"PHOTOPOLYMER" PLATES

ity-diminishing variations are most likely to occur—it is claimed that the use of Dycril will result in a superior printing plate.

Many advantages

Attesting to Dycril's advantages is the fact that there are already about 40 commercial plate makers and some 30 printing shops that have invested in special equipment (*e.g.,* exposure frames and washout cabinets) to produce the plates. The number of commercial printers using the plates is also growing.

One of the latter group, Pantone Press, New York, N. Y., specialists in letterpress printing of high-quality color displays and merchandising materials, lists the following reasons for switching almost exclusively to the use of Dycril plates:

1) Superior ink receptivity and the ability to transfer the ink more evenly to paper.

2) Uniformity of reproduction, not only as far as the original plate is concerned, but also in the duplicate plates as well, since the latter are produced by the same method as the original as opposed to the technique used for metal plates, in which duplicate electrotypes are made from impressions of the original engravings. (Such electrotypes can be produced from Dycril plates).

3) Longer wear. A Dycril plate will withstand up to 1 million press impressions. Copper or zinc plates have to be chrome-plated to achieve such durability.

4) Lighter weight, for easier handling and economies in shipping the plates long distances.

While there seems to be general agreement on the quality advantages of the photopolymer plates, the question of their economics is a more complex one, tied in with the kind of printing process and techniques involved and the general level of print quality being sought after. A company publishing an annual report may pay more initially for a photopoly- **(To page 164)**

Photographs for this story were printed from Dycril plates produced for MODERN PLASTICS by Primary Color Inc., New York, N. Y. Cost of the plates was $26.88, copper engravings of the same size, ordered under similar one-time commercial conditions, would have cost $23.48.

PANELYTE CASE in use at Wayne Dairy Co., Richmond, Ind. Standard wooden cases are on conveyor line at left, with one damaged case visible at left foreground. Cases are completely interchangeable with traditional units on all dairy equipment. Photo, Phillips Chemical Co.

Beverage cases:

High-density polyethylene is on the threshold of adding to its market base an industry which, according to some observers, may ultimately account for annual resin sales in excess of 100 MILLION POUNDS!

Exactly how big the beverage case market is, no one knows for certain; but most estimators place the number of cases in use today at around 30 to 35 million for milk, considerably higher for soft drinks, and for beer cases even higher—close to 1 billion according to some observers. Again, no specific data exist on the annual replacement market; however, a rule-of-thumb figure frequently quoted is 10% of the totals above. Finally, just what portion of the market will swing to polyethylene is another big question.

But one thing is sure: both in terms of economics and performance, injection-molded, high-density PE cases are ideally suited for this use.

The case for dairies

Of the milk cases in use today, 70% are designed to hold 16 one-qt. or 9 one-half-gal. paperboard containers. It is this 70% of the market that PE is after.

Conventional materials of construction are hardwood, hardwood-metal combinations, softwood, aluminum, and wire.

How these materials compare with polyethylene in terms of weight, price, and service life is summarized in the table at right. As is apparent from the tabulation, molded high-density cases are in an excellent position to become the new standard material in this field. Many dairy spokesmen predict that within three to five years, the high-density PE case will be the universal case in this field. Just on a price/service life basis alone, molded PE milk cases are less costly than those made of the other materials. And this does not take into account the annual repair costs for wooden cases (about 30-50¢ per case), the downward trend of high-density prices compared with the increasing costs of wood and metal manufacturing, or improvements in processing technology.

But that's only the beginning of the story.

Take weight, for example. Many bottlers main-

coming market for high-density PE

tain fleets of trailer trucks to distribute milk within the region they serve. Because of legal weight limits on loaded trucks, the vehicles generally operate at only 80% of load capacity. By switching to PE cases, sufficient weight is saved to permit loading to 100% of milk capacity. Studies of this operation have shown that the 100% load can save the shipper almost $1500 per trailer per year; or, it may make it possible for him to reduce the size of his fleet by 20 percent.

Lower weight, of course, also means greater ease of handling. And while this advantage is not readily translatable into dollars and cents, it will obviously result in faster stacking and unstacking, more efficient loading, and improved handling at the retail outlet.

Or take safety. Again, it's hard to pin-point just how this is going to show up on the balance sheet. But wooden cases do splinter and the nailed metal straps do come loose, resulting in possible injury to workers and customers, who will generally not shrink from instituting legal action. With the PE case, there are no splinters and no metal strapping to become detached; thus, liability insurance rates should come down.

And how much is merchandising value worth? The alert milk distributor can take effective advantage of both the clean appearance of the new case, the possibility of identifying color, and the chance of carrying highly legible advertising copy right on the container. A slogan such as *Look for the milk in the blue case* can represent a strong promotional asset. It would be particularly effective since the plastic case could readily be displayed in the store's dairy cabinet (thereby reducing in-store handling). Because of their dismal appearance, this merchandising technique is not feasible with wooden cases.

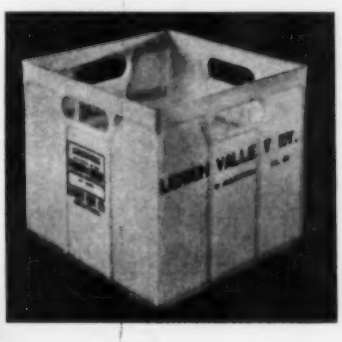
What about the color plus? PE cases can be molded in a whole rainbow of integral hues, which never need repainting. These colors can be used for company identification or for coding the cases for contents. In either case, it's an advantage not available with conventional cases.

And cleanliness. Obviously, the PE case is

Milk case materials—weight, cost, life

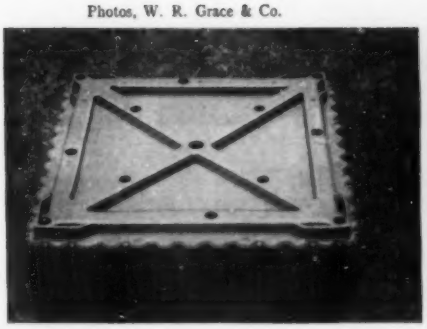
Material	Approx. weight	Price range	Expected life
	lb.	$	years
Hardwood	9	1.25—4.00	2—3
Hardwood-metal	12½	2.00—4.00	2—3
Softwood	10	1.00	1—3
Wire	9	3.25—3.75	3—5
Aluminum	9	3.50	3—5
High-density PE	3—4½	3.00—4.25	6—10

Milk cases



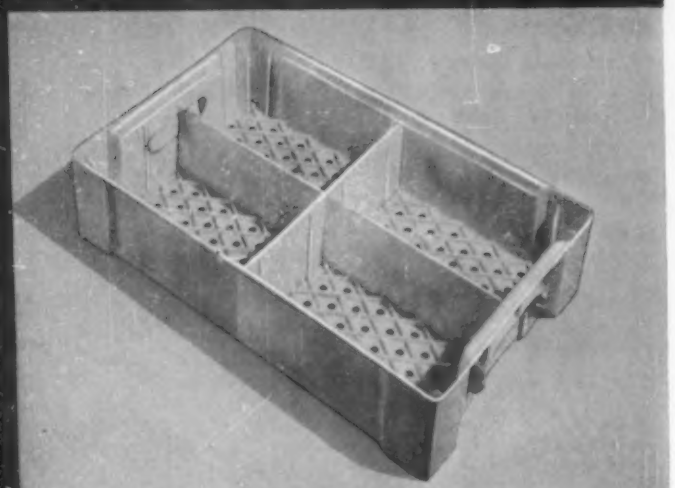
BAKER BOX milk case. Note reinforcing ribs used to provide rigidity and strength. Two sides of case are used for dairy logo, the other two for a protective warning that is designed to keep pilferage to a minimum.

Photos, W. R. Grace & Co.



DUNNING CASE is distinguished by fluted design of walls, said to provide requisite strength with minimum use of material. This design also brings the case up to the dimensions necessary to make it interchangeable with wooden and wire cases on dairy equipment. Photo at left gives detail of bottom construction and stacking lugs. Photo at right gives detailed view of ribbed reinforcement just above gripping hole.

Soft drink cases



UNION CARBIDE soft-drink cases. At top is a 24-bottle unit, with molded-in egg-crate dividers. Company logo is attached in recessed area at sides of case. Below is four-compartment unit, designed to hold four six-packs. Note drainage holes and ribbed reinforcement at bottom.

more sanitary than its wooden counterpart. It can withstand steam cleaning in caustic or acid solutions. It has no cracks where dirt, germs, and bacteria can accumulate.

Product protection is another important point. Because of the resilience of the material, cartons carried in PE cases are better cushioned than they would be in wood . . . which results in fewer leakers. And since there are no burrs, wire ends, sharp seams, splinters, and the like to puncture the paper container, loss—and consumer dissatisfaction—from that source is practically eliminated.

Finally, many dairies are forced to maintain their own repair shops to fix damaged wooden cases. Those that switch over to PE cases are in a position to discontinue these facilities, making the space available for more productive efforts.

Who is in the field

At the moment, three companies are producing such milk carton cases: Panelyte Div., St. Regis Paper Co., Cambridge, Ohio; J. H. Dunning Corp., Darien, Conn.; and Baker Box Co., Worcester, Mass. While each of the companies has developed its own design, they all hew closely to the norms established over a long period by wooden cases. The companies are fully aware that the change-over will be a gradual process, that dairies will not discard their existing equipment in order to make the change. The new cases, thus, must fit into existing production facilities and be usable with wood on an interchangeable basis. Most dairies are expected to mix the new with the old cases as they start using the plastic ones.

The Panelyte case: Panelyte produces these cases on a proprietary basis and distributes them through Ex-Cell-O Corp., Detroit, Mich.

The biggest end user is Mayflower Milk Co., Portland, Oregon. The case, with 12¼ by 12¼-in. inside dimensions, weighs 4½ pounds. Cost ranges from $3.88 to $4.25, depending on quantity; the cases are also available on lease at a cost of $1.08/year, including a purchase option.

As can be seen from the illustration (p. 88), the case has smooth walls all around, providing maximum area for advertising copy. It also has four grip holes so that it can be grasped from any position and requires a minimum of stacking alignment.

The units are molded in a single-cavity mold with five gates and a hot runner system on a 120-oz. ram-type injection machine using Marlex resin with a density of 0.950 and a melt index of 3.5.

The Dunning case: This version (see photo, p. 89) is custom molded for Dunning by Prolon Plastics, Florence, Mass., and is distributed by Dunning to dairies. Dimensions of the case are 13½ by 13½ by 11 inches. Weight is 63 oz., and cost is $3. This case has fluted walls. This design permits a reduction in material usage while maintaining requisite strength and effective wall thickness. It also adds a decorative touch to the appearance of the case. Part of the walls are left flat to permit imprint of tradenames.

The case is molded in a single-cavity mold on a 300-oz. ram-type injection press, using a hot runner system and eight gates. The resin is Grex with a density of 0.960 and a melt index of 2.5.

During recent weeks, W. R. Grace has been

Beer cases

DUQUESNE beer case holds 24 bottles, uses disposable paperboard egg-crate dividers. Case is molded in one piece, incorporates integrally hinged double lid. Case in background is old fibreboard container, which the plastic case will outlast many times over. Photo, Koppers Co. Inc.

Photo, Jas. H. Matthews & Co.

STEEL DIES used in foil leaf hot marking of Duquesne beer case. These are said to be among the biggest hot leaf dies ever made.

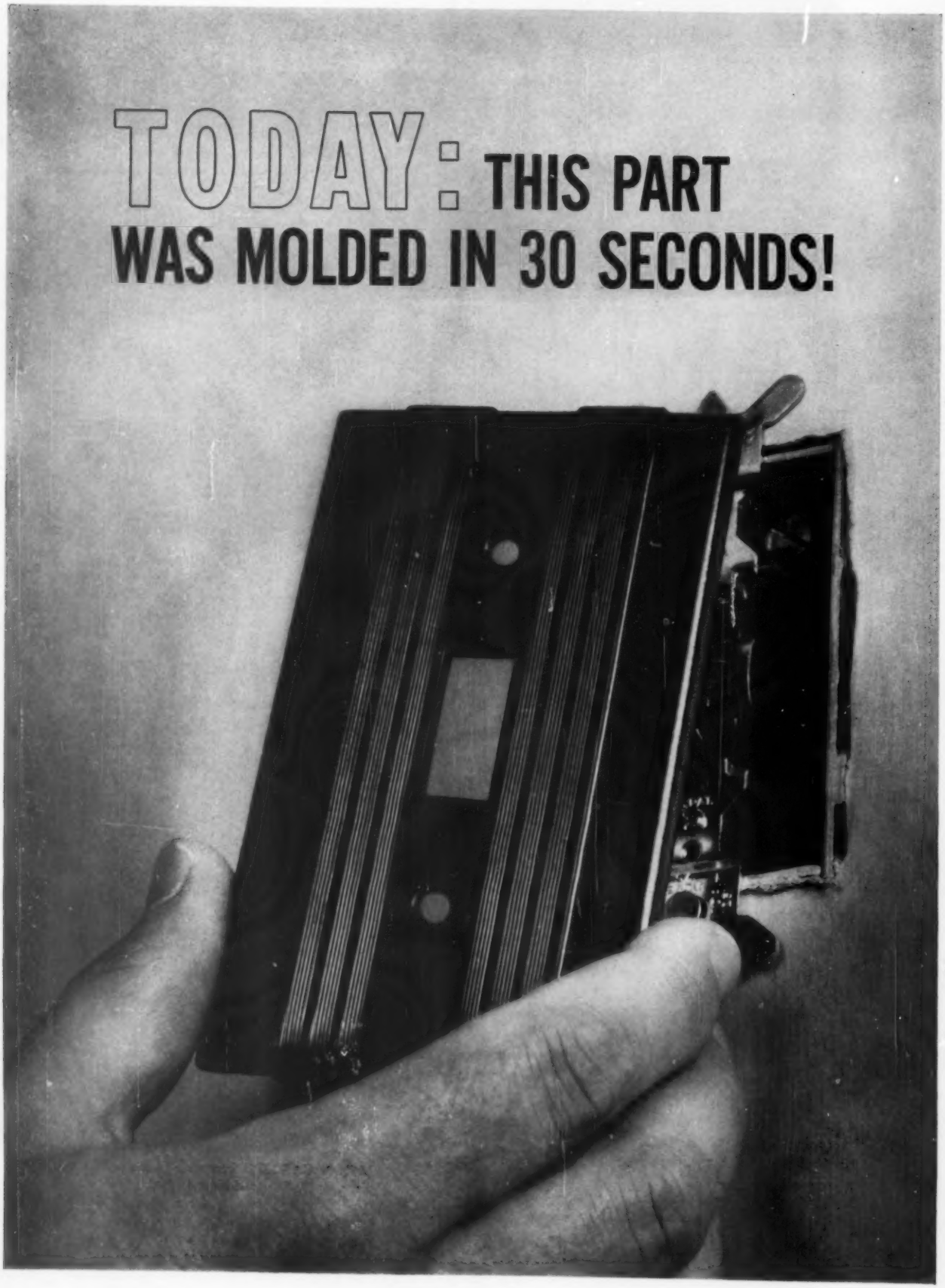
molding the case on a demonstration basis at its Clifton, N. J., technical service laboratory, using a screw plasticating injection machine on cycles running as low as 62 seconds. Company spokesmen feel that milk cases (and similar large moldings in the tote box class) will ultimately be universally molded on screw plasticating injection machines, possibly using lower-melt index resins which have improved strength properties.

Baker Box Co. case: The company, of Worcester, Mass., one of the top three jobbers of dairy equipment, has also jumped into the market. Baker Box's case, which has inside dimensions of 12¼ by 12¼ in., weighs 4 lb., and retails at $2.85 in carload quantities and in natural color, including hot-stamping of the dairy's name in any color on two of the four sides. Up to three lines of stamping are provided. The company will furnish the case in any color desired by the dairy, at an additional 15¢ per case. The case is molded for Baker Box by Mack Molding Co., using Marlex high-density material.

All three milk cases have molded-in drainage and handle holes. All incorporate ribbing systems to provide strength and stiffness. All incorporate some stacking feature to prevent slippage—molded-in lugs, recessed rims, or other devices. And all of the cases can be produced in a wide range of colors.

Sales of the PE cases so far have been anything but spectacular, which, considering the tremendous advantages offered by the new **(To page 151)**

UNION CARBIDE beer case is molded in one piece, including self-hinged double cover and molded-in egg-crate dividers. Weight is 3¾ pounds. Logos are printed on pressure-sensitive vinyl, attached to all four sides.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BMGA-4127 and **BMGC-4011** still in the development stage, promise completely new thresholds of heat- and arc-resistance for phenolics. Laboratory tests reveal 4 times longer strength retention at 500°F. Can be used at temperatures 75° higher. ASTM arc-resistance values: 195 seconds average . . . 180 seconds minimum.

Want more information about new developments in BAKELITE phenolics? Just write Union Carbide Plastics Company, Dept. JZ-87H, Division of Union Carbide Corporation, 270 Park Avenue, New York 17, N. Y. *In Canada:* Union Carbide Canada Limited, Toronto 12.

UNION CARBIDE **PLASTICS**

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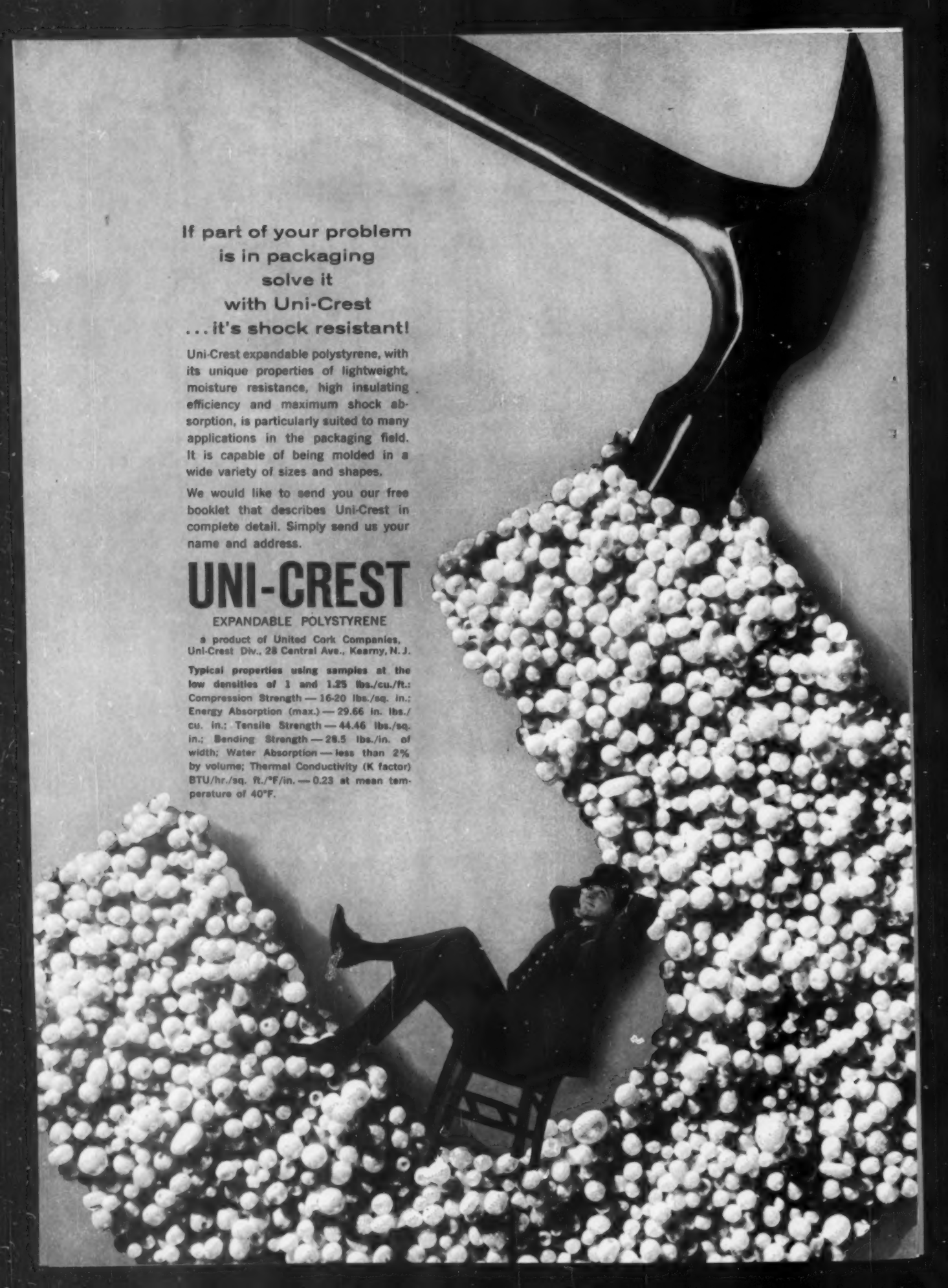

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George R. Smoluk, ENGINEERING EDITOR

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A guide to ultrasonic sealing equipment

What it is, how it works, and what can be done with it

By Howard Deans†

The science of ultrasonics originated more than 75 years ago as a laboratory curiosity. Since that time ultrasonic energy has been used for various purposes, the latest development of which is the welding or bonding of plastic film and fabrics.

Although the exact mechanism by which the sealing of plastic film is accomplished by ultrasonic energy is not clearly defined, the theory is that ultrasonic vibrations can be used to induce high-frequency mechanical working of the plastic which, in turn, generates internal heat and effects fusion of the material. The working may take the form of rapid compressions and decompressions, or may result in rubbing one surface over another to generate frictional heat. The net effect may be a combination of both. In any case, ultrasonics have been used to seal various plastic films, and commercial ultrasonic plastic sealing equipment is now being made available.

The business end of a typical ultrasonic sealing machine is shown in Fig. 1, p. 97. Although differing in design detail and circuitry, all ultrasonic sealing machines contain the following basic components:

1. An electrical high-frequency generator which converts the low-frequency electrical input into an alternating current electrical output with a frequency that is in the ultrasonic range.

2. A transducer which converts the high-frequency electrical output of the generator into a high-frequency mechanical vibration or wave. A magnetostrictive type of transducer (with tool attached) is shown in Fig. 2, p. 98.

3. A tool to carry and focus the energy output of the transducer on the work to be sealed.

4. A hard surface or anvil against which the tool acts on the film.

A schematic diagram of a typical ultrasonic sealing machine is shown in Fig. 3, p. 99.

As shown in the diagram, the power output of the electrical generator is controlled by a variable transformer in the input circuit of the power supply for the power amplifier. With this arrangement, power output may be steplessly varied from 0 to several hundred watts. Typical maximum power output of the circuit shown is about 300 watts. The frequency of the electrical output is controlled by a variable capacitor in the oscillator circuit to resonate the transducer in the frequency range of about 20 kc. Resonance is usually indicated on a meter on the control panel. Oscillator tuning is also sometimes done by using a variable resistance-capacitance network rather than the inductance-capacitance tank circuit shown. Sometimes to simplify the circuitry, the oscillator and amplifier are combined in a self-oscillating power output stage.

The most common oscillator cir-

Like audible sound, ultrasonic energy is transmitted through liquids, solids, and gases by a series of compressions and decompressions of the media through which the energy is traveling. These pulses or waves of energy traveling through a medium can be visualized by thinking of a line of bowling balls which are struck at one end by another bowling ball, thus causing a ball at the other end of the line to move away from the group without the intermediate balls exhibiting any motion. Thus, if the actions are continuously repeated periodically, a mechanical vibration or wave motion is set up in the transmitting medium. Ultrasonic energy travels through a solid in much the same fashion.

In ultrasonics the frequency of this vibration is above the range of frequencies associated with audible sound. The ability of the human ear to detect sonic vibrations varies with the individual; the average ear usually cannot detect vibrations with frequencies above about 18,000 cycles per sec. (18 kc.). As with audible sound energy, the speed of transmission and the efficiency of transmission will depend on the physical properties of the medium through which the wave is traveling. In equipment for ultrasonic sealing of plastic film, the energy is transmitted from the source or generator to the work by means of a solid metallic tool, and the design of the tool is a major factor in providing a satisfactory seal of the plastic.

*Reg. U. S. Pat. Off.

†Vice President-Engineering, Ultra Sonic Seal Inc., a Div. of Kleer-Vu Industries Inc., New York, N. Y.

new!
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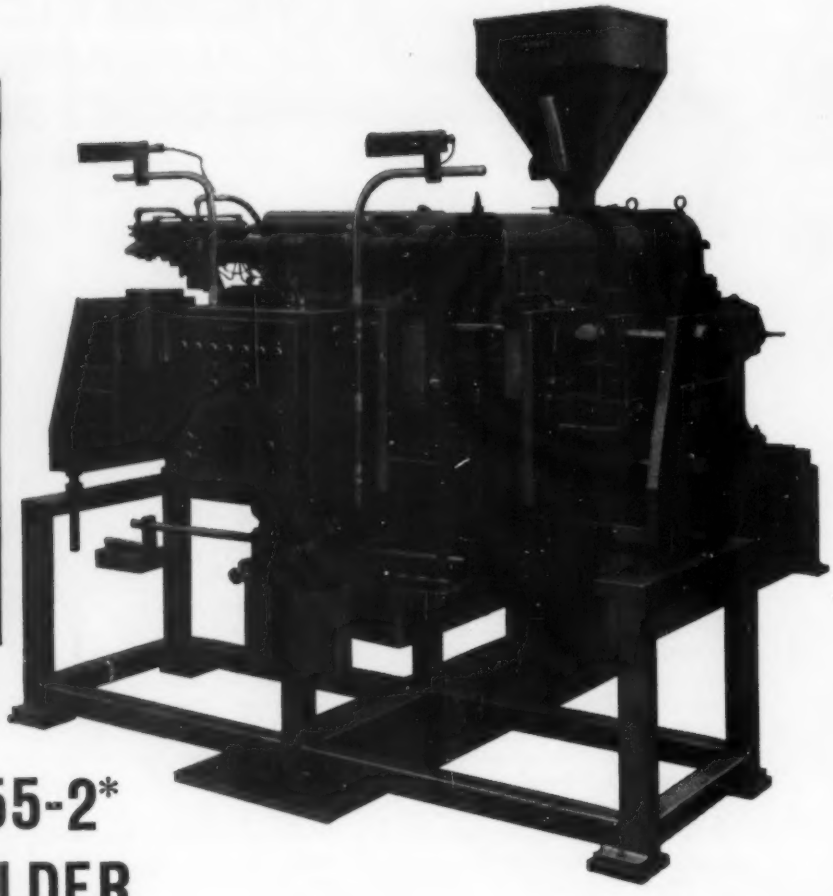

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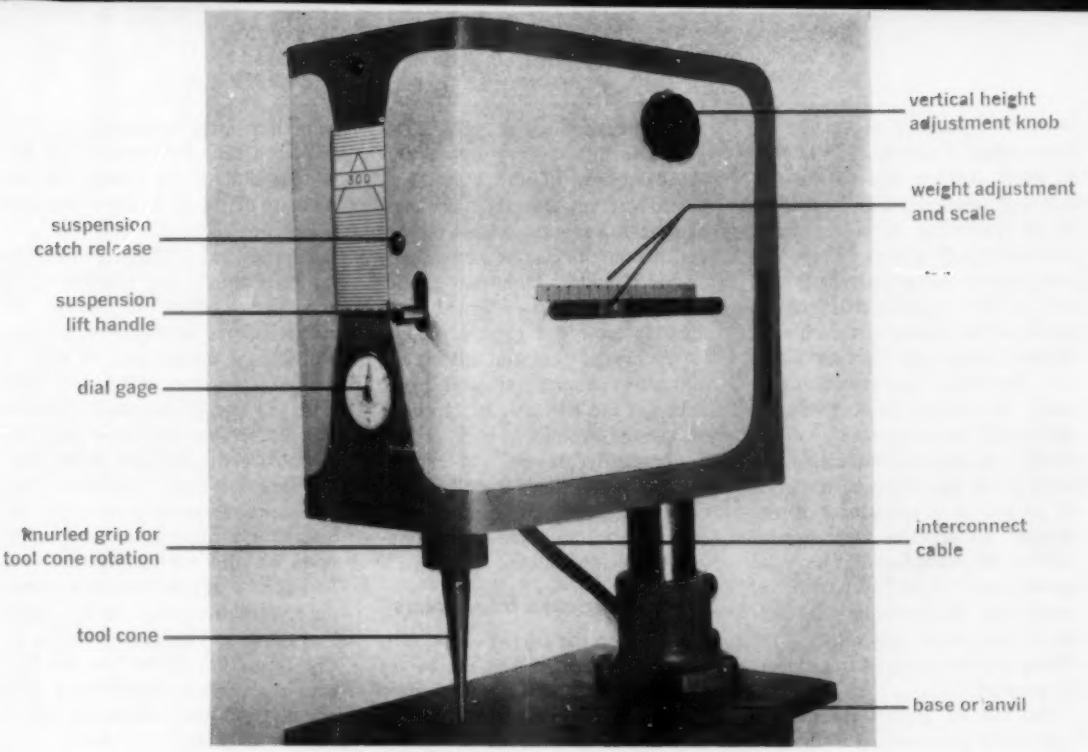

FIG. 1: Typical ultrasonic sealing machine equipped with magnetostrictive transducer showing major features (power supply not shown). Machine shown is Ultra Sonic Seal Inc. Zephyr 300 Model.

cuits in use today are conventional circuits similar to the one shown in Fig. 3, which uses a Class AB_2 power amplifier. Tubes are preferred to transistors because of their ability to take overloading without failure. Usually, selenium or silicon rectifiers in wave or bridge circuits are utilized for the bias supplies.

For film sealing, the frequency generator should have a broad tuning oscillator and transducer, should be designed for heavy-duty operation, and should have a degree of self-tuning ability to maintain resonance as the work load varies. When magnetostrictive transducers are used, a low voltage-high current transducer bias supply is also a requirement.

The output of the frequency generator is converted by the transducer into ultrasonic mechanical energy. Two types of transducers are in use. These are the piezoelectric, or crystal, type and the magnetostrictive type. Both are discussed in more detail below, along with the focussing horn and sealing tool.

The anvil used with the sealing tool can be of any material having a substantial mass and a fairly high Brinell hardness. The anvil is sometimes incorporated as an integral component of the machine's film-feeding system by making it into the form of a driven wheel which moves the film joint to be sealed under the tool. Other types of film feeding systems include a moving bed plate upon which the film is fastened or rested, separate drive rolls, or other mechanisms which pull the seal to be made under the tool tip. In some applications the work remains stationary and the tool tip is moved over the work.

Piezoelectric transducers

These transducers are made with certain natural and synthetic crystals (piezoelectric crystals) which have the inherent ability to undergo mechanical deformation, or changes in dimensions, when an electrical potential is placed across the crystal between two of its faces. If an alternating potential is placed across the crystal, the crystal will deform in an oscillatory fashion in accordance with the applied alternating voltage. Thus, such crystals are able to convert an electrical input of an ultrasonic frequency into a mechanical vibration of the same frequency and generate ultrasonic energy waves.

In the past, quartz crystals were used almost exclusively. More recently, however, synthetic materials have been developed which have numerous advantages over the quartz crystal. Although these materials do not exhibit a true piezoelectric effect as does quartz, they do possess electrostrictive characteristics. Among these materials are lithium titanate, ammonium dihydrogen phosphate (ADP), and barium titanate.

The mode of vibration produced in a crystal may vary greatly, depending on its shape, thickness, and how the electrical potential is applied to its surfaces. Vibrations may consist of twisting effects in the crystal, changes in the disk-radius (in the case of disk-shaped crystals), or changes in thickness, among other types of deformations. Most barium titanate crystals, commonly used today, vibrate in a so-called thickness mode, in which the thickness of the crystal changes in accordance with the applied voltage. The resonant frequency of a barium titanate crystal will vary with its thickness between the electrodes. A crystal about 0.1 in. thick will have a resonant frequency of about 1 megacycle, whereas the resonant frequency of a slab 1 in. thick will be about 100 kc.

Crystal transducers are very efficient converters of electrical into mechanical energy and little of the

electrical input is dissipated in the form of heat losses within the crystal itself. This is due to the fact that the crystal is a high-impedance device requiring a power input combination of a high voltage and low current. Since current is low and the heat generated is proportional to the square of the current, the heat generated as losses is also low. However, the crystal transducer is sensitive to temperature, and when the temperature of the crystal reaches a level called the Curie point, the ability of the crystal to act as a transducer is destroyed. To regulate the temperature of the transducer, it may be air- or liquid-cooled by fans or oil immersion. Water-cooling is difficult to use, since high voltages, required to drive a crystal transducer, are present.

The life of crystal transducers is generally proportional to the size of the temperature differential which is maintained between the operating temperature and the Curie-point temperature.

Through the use of barium titanate crystal, transducers can handle up to 50 w./sq. in. of crystal, but the temperature must be closely regulated to avoid destruction of the crystal. In practice, power densities of this magnitude are seldom used since cooling of the transducer crystal becomes a problem, as does finding satisfactory methods of mounting the crystal in the transducer or attaching the crystal to sealing tools. A more common power density used is about 20 w. per sq. inch.

Advantages of the crystal-type transducer are that they are inexpensive to manufacture, have high conversion efficiencies, and employ simple circuitry. Disadvantages include the problems presented in cementing tools and focussing cones to the crystal face and subsequent difficulties in changing tools. Also, although the tool side of the crystal can be grounded, high voltage is necessarily present. The crystals are fragile (although low-frequency types are large and rugged), and they can be destroyed by continuous high temperatures.

Magnetostrictive transducers

Similar to the crystal transducer, this type of device uses the ability of certain metals to undergo minute expansions and contractions when subjected to an oscillating magnetic field. These effects are of the greatest magnitude in such metals as iron, nickel, cobalt, and their alloys. The most commonly used metals are nickel and Permalloy. Figure 4, p. 101, shows how various metals react to an increasing magnetic field strength. Similar to the crystal transducer, the magnetostrictive effects in metals also fall off with increasing temperature and completely disappear at the so-called Curie point. See Fig. 5, p. 101. However, unlike the crystal, the magnetostrictive transducer can recover from this treatment. In addition to the loss in effectiveness with increasing temperature, there is also a shift in frequency of the output due to the change in the velocity of sound in the hotter metallic core material.

The general design of a magnetostrictive transducer consists of a rectangular stack of nickel or nickel alloy laminations around which an electrical coil of wire is wound. A tapered section is brazed onto the end of the stack. To this tapered section an additional detachable cone and tool holder can be threaded and attached. The transducer is usually mounted by attaching a support at a velocity node on the tapered section. To function, a magnetostrictive transducer must be polarized by a d.c. bias current. The circuit shown in Fig. 6, p. 101, shows how the d.c. bias is applied to the coil and separated from the alternating ultrasonic voltage input by means of a blocking condenser.

The entire transducer assembly must be carefully cooled during operation; this is especially important in the magnetostrictive type since only about 10 to 25 w./sq. in. of power may be handled without cooling. About 90% of the total heat loss takes place in the metal core, the remainder of the heat being dissipated in the electrical coil encircling it.

Generally speaking, magnetostrictive transducers are most efficient when operated at frequencies between 10 and 60 kc. When frequencies above 60 kc. are to be handled, crystal-type transducers are almost universally used. The electromechanical efficiency of the magnetostrictive transducer falls off appreciably with increasing frequency. The electromechanical efficiency of a well-designed transducer at 15 kc. can be in the order of 90%; it falls off rapidly to 65% at 30 kc.; and is only 35% at 100 kc. Thus, it is best to operate magnetostrictive transducers at as low a frequency as possible consistent with other requirements. The cause for this loss in efficiency is twofold. First, there are hysteresis losses which increase linearly with frequency; and, second, eddy current losses which increase with the square of the frequency.

Among the advantages of the magnetostrictive type of transducer are its ruggedness, imperviousness

FIG. 2: Magnetostrictive type of transducer with energy focussing tool attached. The transducer converts ultrasonic frequency electrical input into ultrasonic mechanical output. Exponential cone at left amplifies and focusses energy on work.

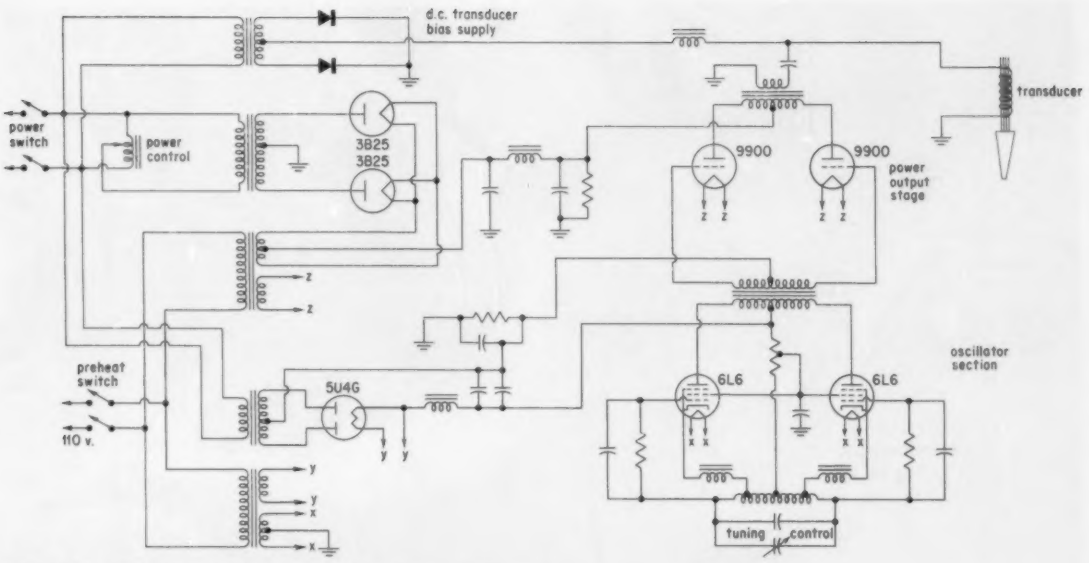

FIG. 3: Simplified circuit diagram of ultrasonic power generator and transducer circuit for magnetostrictive-type transducer.

to destruction by heating, ability to handle high watt densities in the cone core, and the ease with which sealing tools may be attached to the transducer, thus facilitating interchangeability. However, this type is costly to manufacture and it also requires a high-current d.c. bias supply.

Sealing tools

For welding plastics, the amplitude of the ultrasonic vibration produced by the transducer must be "focussed" on the work and further amplified to a usable value. To produce welds, the amplitude of vibration of the tip of the sealing tool should be in the order of 1 or 2 mils. This is done by attaching to the transducer a tool most often cone-shaped, in which the cross-section diminishes sharply towards the sealing end. The shape of the tool is not always in the form of a cone or taper, and the change in cross-section may take the form of a sharp step change or combinations of a step change and taper.

For many applications an exponential taper is used in the tool cone (See Fig. 2). When the tool is tapered exponentially, the cross-section radius changes according to the equation

$$r = r_o\, e^{-ax} \qquad \text{Eq. 1}$$

where r is the radius at distance x along the axis of the tool from r_o, r_o is the radius at the heavy end, and a is the taper factor.

The cone may be made of any solid material in which sonic energy may be transmitted at a high velocity. The velocity of sonic energy in several metals is shown in the table on p. 102. Generally, monel metal is used because it has a high "Q" or sonic energy transmission efficiency.

The tool is usually designed to operate at a frequency matched to the resonant frequency of the transducer and the length of the tool, L, may be calculated using:

$$L = ck/2\pi f \qquad \text{Eq. 2}$$

where c is the velocity of sonic energy in the tool material, f is the operating frequency, and k is a constant which is experimentally, or theoretically, determined for various tools and is dependent on the geometry and mass of the tool.

Exponential cones are theoretically the most efficient. Straight taper cones are sometimes used, since they are easier to machine. However, an exponential cone with a ratio of maximum to minimum diameter of 4:1 has an amplitude gain which is also 4:1. With a straight taper cone having the same dimensions, the amplitude gain which may be expected falls to about 3.15:1.

To do the actual sealing, supplementary tips are added to the tip of the cone. These are usually made of an extremely hard material such as tungsten carbide and brazed to the tip of the cone; they are shaped according to the type of weld desired. If the tip length is less than 0.375 in., no adjustment of the tool cone is necessary. When the tip is longer than 0.375 in., then the tool must be shortened by an amount equivalent to the weight of the tip being used.

Since the amount of motion at the end of the tip is relatively large, the acceleration of the mass of the tip, moving at ultrasonic speeds, is very high, and problems arise in fastening this tip in place. Threaded connections cannot normally be used. Instead, a mechanical tongue is usually employed, and the entire tip is brazed into a mating groove in the tool cone.

Tips wear to some degree in the ultrasonic welding of plastics, since there is always some abrasive material present at the work surface, either in the plastic itself, on the surface, or in the air. However, tips need not be discarded when wear becomes evident, since they may be dressed for further service.

Operation

To execute a weld, the tool must be applied to the plastic film so that it exerts pressure upon the material. With a small tip, a few

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pounds of pressure applied to the tool results in 1000 p.s.i. or more in the film. This pressure should be applied evenly, regardless of variations in film thickness.

In one machine design, this is achieved by a free-floating suspension system which supports the transducer and allows it to move freely while maintaining constant pressure, perpendicular to the film. A stop is provided by which the suspension system permits the tool to penetrate into the plastic to a predetermined depth while fusion is taking place beneath the tip.

There are various ways of imparting ultrasonic energy to different materials to promote fusion and welding action. In rigid materials of a relatively non-compressible nature, such as thin metal sheets or foils, the materials can be welded or bonded by utilizing a "shear wave" mode of operation. Here, vibrations of the welding tip are parallel to the surface of the material. At the same time, the welding tool acts to keep the material under compression.

However, in the bonding of plastic materials, it has been found much more efficient to utilize the "compression wave" mode to create a weld. This involves vibration of the tool perpendicular to the two films being joined. Compressing and decompressing the resilient plastic at such a high speed generates heat internally in the material and fusion results.

The speed at which a seal can be made is theoretically dependent upon many factors and can usually be best determined by experiment. Assuming that each high-speed blow of the tool tip imbeds it into the plastic so that all of the energy it delivers is imparted to the compressed film, a substantial portion of the mechanical energy is transformed into heat. The remainder is dissipated in the form of sonic energy transmitted through the film or into the air surrounding it.

The specific heat of the plastic involved fixes the amount of energy necessary to raise the mass of the welded area to the fusion point. A goodly portion of the ultrasonic energy is applied to the plastic in the form of heat, if the proper welding conditions are met. This is dependent upon the resiliency constant of the film itself, the

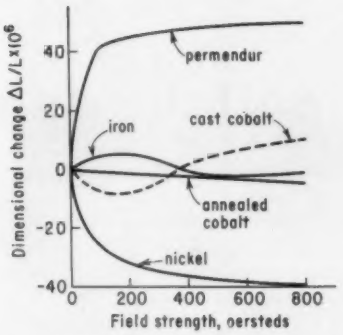


FIG. 4: Graph showing dimensional changes which may be induced in various metals when subjected to electromagnetic fields of varying strengths.

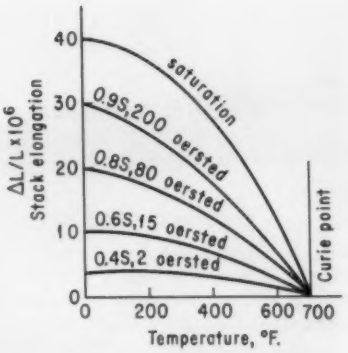


FIG. 5: Graph showing the effect of temperature on the ability of nickel stack to exhibit magnetostrictive effect (changes in dimension) when exposed to fields of varying strength. At the Curie point, metal loses its magnetostrictive properties. In electrostrictive crystal type transducers, exceeding Curie temperature destroys the crystal; in the magnetostrictive system, the metal stack recovers from this inability to act as a transducer.

coupling coefficient of the tool to the plastic, the speed of the film advance, the gage of the film; and, more importantly, the rate at which the surface heat is carried away through the anvil and tool tip. The effect is a complex one involving many factors and makes predictable results difficult.

The new sealer can be used with materials ranging in total thickness from ¼ to 100 mils. Fig. 7, p. 102, shows a photomicrograph of a Mylar film seal. In continuous welding, sealing speeds of 100 linear ft./min. have been obtained.

As to the width of seals, bonds can be made in most materials up to ½ in. wide in practical applications by increasing the power applied. Beyond this, continuous welding becomes too slow.

One-shot bar seals of short length can and have been made. Generally, they are limited to the practical physical dimensions of the tool itself. Some equipment has accomplished bar seals from 1 to 1½ in. long and up to ⅛ in. wide. With a moderate power increase and proper tool design, bar seals 2½ in. long can be produced.

The most common type of tool used is the one shown mounted in the equipment in Fig. 8, p. 102. It should be noted that materials being welded can be moved between the anvil and tool tip at varying rates of speed. The plastic can even come to a complete standstill without any overheating or burning taking place. The suspension system permits the transducer and the attached tool to drop into the fused material to the predetermined depth and no further, as an

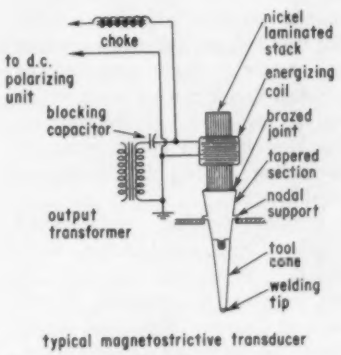


FIG. 6: Schematic drawing of magnetostrictive transducer, showing d.c. bias connections and ultrasonic frequency input circuit. Nodal support is placed in the assembly where no vibration takes place, i.e., at a node.

equilibrium is reached which prevents any further transmission of energy to the film.

A simulated "butt" weld of two ends of plastic can be effected by using a modified technique. In this case, a relatively large-area tool is used, but the requirement for small-area energy concentration is satisfied by using a very narrow lap of the two butted ends. This lap may range anywhere from about

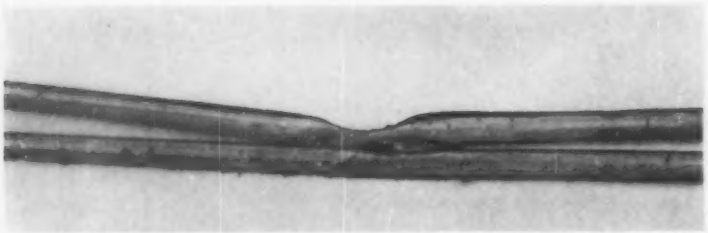


FIG. 7: Photomicrograph showing cross-section of seal made between two pieces of 5-mil Mylar film. Thickness at the point of the weld is about 7 to 8 mils. Note from this evidence that fusion has taken place only on the inner surfaces of the film.

15 to 125 mils or more, depending upon the power applied and pressure utilized.

Fig. 8 shows a cross-section of two ends of plastic as they are overlapped on the anvil. Also indicated is how the tool, which is much wider than the lap, fuses the two ends together and flattens them out so that the resultant bond is not much thicker than that of one single film thickness. This provides a particularly strong type of seal. A tensile test of two strips of Mylar, each 3 mils thick, joined in this manner resulted in the joint's holding well beyond the point at which the material itself stretched or yielded. Bonds can be made which are 85 to 100% of the ultimate breaking strength of the material, depending upon the particular plastic used.

Besides welding conventional plastic films, considerable work has been done with the sealer in the bonding of synthetic fabrics such as Dacron, Orlon, and nylon. Here, an interesting phenomenon occurs, for the very nature of the bonding operation causes the retention of a semi-fibrous structure in the weld area: the thermoplastic material is not fused into a solid mass. The semi-fibrous makeup of the bond leaves the material quite flexible, unlike the stiff fused bonds which occur when standard heating methods are used.

A modified technique can also be employed with the sealer for the cutting of synthetic fabrics. With this method, the cut edges become neatly fused. It prevents unravelling, an ever-present problem with this type of material due to the smoothness of the individual fibers. The resulting cut edge is also attractive in appearance. Thus, the ultrasonic sealer may possibly eliminate the need to hem the edges of conventionally cut fabrics to prevent fraying.

Another interesting application of the sealer involves the fusing of plastic-coated papers and foils. In this case, the sealing of the plastic must be accomplished between the two outer surfaces of the paper or other material being fused. This has always presented a problem with standard heat sealing methods, because they require application of the heat through the paper to fuse the plastic. Since the paper acts as an insulating barrier, burning frequently results. This is a general occurrence when heavy kraft papers are used. Attempts to circumvent this call for the utilization of materials coated with low-melting-point plastics.

Use of an ultrasonic sealer removes the difficulty. Since it generates heat internally, the device is ideally suited for this type of bonding. It is now possible to weld such materials as nylon-coated kraft paper. The sealing operation may be halted while the tool remains on the work and the material will not in any manner be damaged or burned. This is especially advantageous in construction of multiwall paper bags, where an inner plastic bag sandwiched between outer layers of paper bag can be selectively sealed without harming the paper.

Ultrasonic welding must generally be effected between two like materials. However, under certain conditions, bonds can be made between unlike materials. These may involve joining plastic to paper or cloth. In such cases, the fused thermoplastic is forced into the very fibrous structure of the paper or cloth by the highly concentrated pressure at the tool tip. This causes a mechanically interlocked bond.

Another advantage of ultrasonic welding, compared to standard dielectric and heat, or impulse, types of sealing, is the ability of the new equipment to bond plastic films coated with contaminants.

Bonds have been made on plastics coated with oil, grease, powder, photographic emulsion, inks, and oxide recording coatings. The natural cleansing action of ultrasonic energy prepares the surface prior to welding. This is illustrated by the application of a Zephyr 300 sealer at Union Switch & Signal Div. of Westinghouse Air Brake Co., Swissvale, Pa., for the manufacture **(To page 165)**

VELOCITY of sonic energy in metallic alloys used for sealing tools

Material	*Velocity* 10^5 *in./sec.*
R Monel	1.804
K Monel	1.847
Monel	1.795
Steel	1.99
Brass	1.407

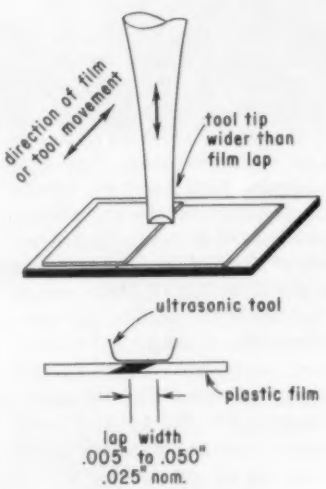


FIG. 8: Schematic drawing showing how a simulated "butt" weld is made between two pieces of plastic film. Overlapping edges are smoothed into diagonal weld across cross-section of the film (lower sketch) so that total thickness at the joint does not exceed thickness of single film.

Molds for encapsulation

By C. A. Harper*

A major factor in the successful production of embedded electronic packages is the judicious use of molds, tools, and fixtures. This factor is particularly important in controlling the various costs as well as the efficiency of the manufacturing operation.

Molds are required for many embedment packaging jobs. Other tools required in these processes include saws, mills, and sanders of various types which are used to remove mold flash and to finish the castings. Other equipment is required for stamping designations on finished parts. If the cast parts are to be coated, then dip tanks may be required. Many more specific tools, such as fixtures and gages, are required for individual jobs. However, this article will be devoted primarily to information relative to the more widely used types of casting and embedment equipment available.

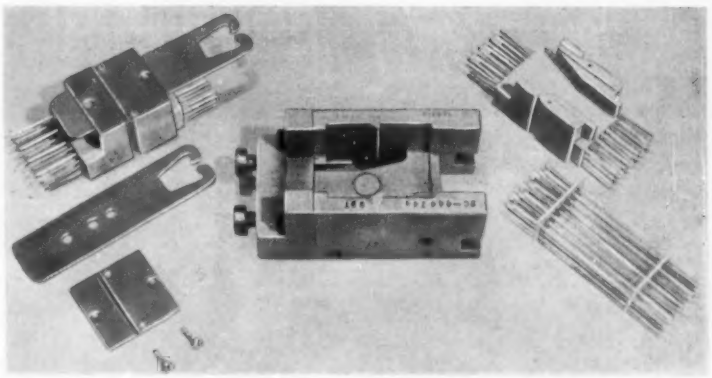


FIG. 1: Machined metal mold used for potting and encapsulation of electronic parts. Machined metal molds are used for complex parts and those containing inserts as shown above.

Molds

Molds for casting and encapsulation are made from a variety of materials in several ways. Most widely used mold materials are metal, plastics, wood, plaster of paris, and sometimes glass. Each type of mold will have good and bad points, and a choice must be made that is based on the application and economics.

Machined metal molds

Molds of machined metal are used when the part is complex in shape or has many inserts. An example of such a part, with its mold, is shown in Fig. 1, above. Such molds can usually be made more accurately by machining than by any other method. However, machined molds are relatively high in cost and, since many electrical part applications do not involve extremely complex shapes, machined metal molds are not commonly used in volume jobs.

Metal molds are good heat conductors. When oven cures are involved, the rapid and uniform transfer of heat through the metal mold produces a more uniform rate of cure. Thus, there is less risk of getting an undesirable differential in curing rate throughout the part than there is in molds of other materials with lower thermal conductivities. However, good thermal conductivity is sometimes a disadvantage. For example, when exothermic heat of reaction is required to help cure the part, the loss of heat from a metal mold may retard the cure. This is most critical when using room-temperature curing compounds; here the conservation of exothermic heat is essential. In some cases, heat loss may be great enough to prevent cure entirely.

When a machined metal mold is used, it is often desirable to chrome-plate and polish mold surfaces which will contact the embedment material. Chrome plating not only provides a harder, more durable mold surface, but also reduces adhesion of the compound to the mold. In fact, if compound adhesion is naturally low, such as with some polyesters, a chrome-plated surface requires little or no mold parting agent, as contrasted to molds that are made of epoxies and other materials.

Cast aluminum molds

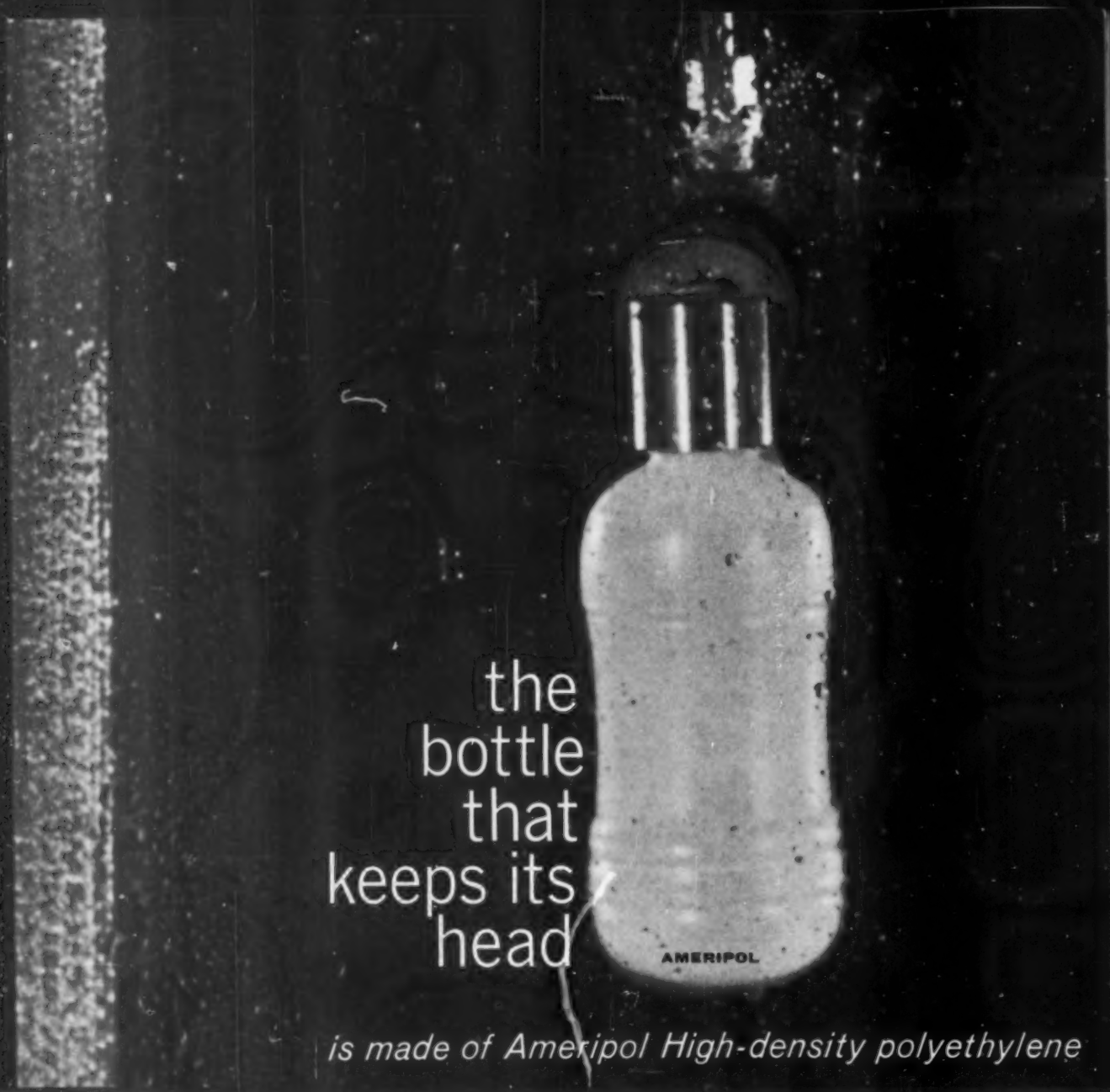
Metal molds may also be cast rather than machined. A popular metal used for such molds is aluminum. The transformer mold shown in Fig. 2, p. 106, is an example. Such molds are relatively low in cost since many molds are made from one pattern or hob. Unfortunately, a cast aluminum mold usually will not have a smooth surface when cast. If the user requires a smooth surface, the mold cavity must be polished and/or plated, which adds to the cost. Another disadvantage is that the average encapsulator does not have facilities available for making these molds. Thus, the patterns and molds must be obtained from an outside supplier. This means that cast metal molds cannot normally be produced on short notice as can those made by other methods that will be described.

Sprayed metal molds

Metal spraying techniques can be used to make low-cost molds(1)[1]. The process consists of spraying molten metal onto a mas-

*Materials and Processes Section, Westinghouse Electric Corp. Adapted from author's book, "Electronic Packaging with Resins—an Engineering and Manufacturing Guide," published by McGraw-Hill Book Co. Part I, describing systems for mixing, metering and dispensing resins, appeared in the April issue of **Modern Plastics**, p. 105.

[1]Figures in parentheses designate references at end of article, p. 175.



In the dramatic torture test shown here, identical containers were blow-molded from Ameripol high-density polyethylene . . . and from another high-density material. The Ameripol bottle and the control bottle were then subjected to an increasing head of hydraulic pressure. In hundreds of test runs, the Ameripol bottle outlasted its opponent every time. When the control bottle ruptured, the Ameripol bottle was still pressure-tight. Then hydraulic pressure was again applied to the Ameripol bottle until it failed . . . at values ranging from 20% to 50% above the control bottle. This extra strength and durability of Ameripol high-density polyethylene can help you produce better quality containers and other blow-molded products at no extra cost. And Ameripol has one other outstanding advantage—it is easily processed on conventional equipment. For strong, beautiful blow-molded products check Ameripol. Write for Ameripol Technical Data file for complete physical properties and specifications. And, remember—Goodrich-Gulf Technical Service can help you with application.

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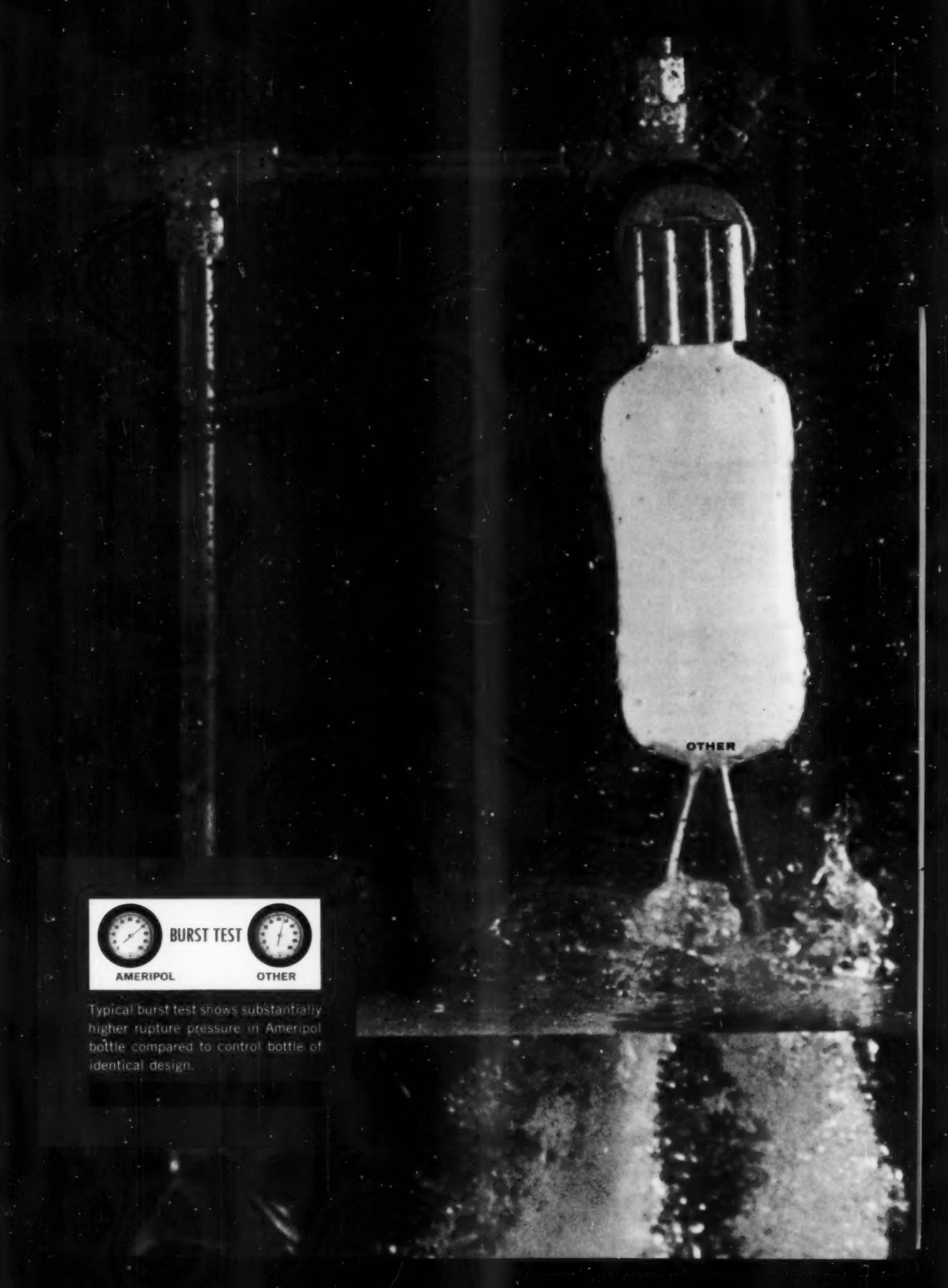

Typical burst test shows substantially higher rupture pressure in Ameripol bottle compared to control bottle of identical design.

ter pattern until a shell of predetermined thickness is formed. The thin shell is then removed from the master and backed up with any suitable material, such as resin, gypsum cements, etc.

A high-quality master pattern or model of the part is required since the sprayed metal will reproduce the master with great fidelity.

It is desirable to use rigid, high-melting materials to make master models, but many low melting materials can be used. For example, it is feasible to metallize patterns or a variety of thermoplastics such as vinyls, cellulosics, etc. In any case, the surface onto which metal is to be deposited should be thoroughly dry prior to spraying. A variety of metals including lead, zinc, tin, etc., have been successfully deposited on such diverse master model materials as vinyls, Thiokol, various rubber compositions, etc., without any special preparation of the surface other than cleaning.

In the preparation of rigid master surfaces for metal spraying, a very thin film of mold release agent will help to release the sprayed metal form. However, production of a sprayed metal deposit is a problem in cases where an excess of release agent is used or where an extremely smooth master surface is encountered. A similar situation may arise with certain combinations of metal and master materials. In such cases, the deposition of a thin preliminary coat of tin or zinc on the master has been found to be helpful. Rotating the master as it is being sprayed will help to achieve maximum coating uniformity.

The metals used for forming the mold by this method are low-temperature melting alloys. The simple procedure involved allows the user of the casting or embedment process to make his own molds. This saves time in translating mold designs into completed molds ready for production.

Dipped metal molds

In the dip method, a polished metal master mold pattern is dipped into a vessel of molten metal and immediately removed. See Fig. 3, p. 107. During the brief immersion, a shell of metal freezes on the pattern. This shell is removed from the pattern and forms the casting mold. The only machining involved is in the shaping of the master pattern.

An eutectic alloy, one which has a sharp melting or freezing point, is best for the dip molding process (2). One of the best of such alloys, Cerrotru, has a melting temperature of 281° F., high enough to withstand the curing temperature of most encapsulating resins. When curing temperature exceeds the melting point of Cerrotru, the embedment casting is removed from the mold, after an initial curing period at lower temperature, and then the cure is completed outside of the mold.

Major advantage of the dip mold system is the reduced embedding production line set-up time, compared with the use of permanent molds (3). For example, a 100-unit run with two permanent molds would take 50 setups, while only one setup is necessary using the dipped molds; 100-dipped molds could be made in minutes, and the metal melted and reused when the run is over.

Cerrotru is interesting in that it expands after it solidifies. This slight expansion (0.0005-in./in.) allows for easy removal of the master. Other metals, such as tin (melting temperature 450° F.), shrink when they freeze and are difficult to remove from the master pattern.

Epoxy molds

The use of epoxy molds for embedment has become popular. Reasons are the extreme ease with which the mold is made, low cost of the mold, low shrinkage, and good strength of the epoxy material. A good example of how a simple epoxy mold can replace a more complicated machined metal mold is shown in Fig. 4, p. 107. In this case the only significant cost in making the mold is that of machining the master mold pattern.

Master patterns may be made of either steel or aluminum, and properly maintained, can be used to make many molds. It is possible to make several epoxy molds within a day or so after the mold is designed, depending on the curing cycle of the epoxy mold material. When an epoxy compound is used for embedment it is often possible to use the same material for both the mold and for the embedded package. However, better epoxy molds can be made by using special, highly filled epoxy compounds containing powdered steel or aluminum fillers. Thermal conductivity is improved and the mold has properties that are very similar to a metal mold.

As mentioned, the all-metal mold has the advantage of greater thermal conductivity. However, the advantage may be overcome by preheating the epoxy molds before filling. Preheating is often required anyhow to minimize air entrapment, thus it is not an added inconvenience.

There are times when producing a smooth surface on an epoxy mold is a problem. This can be solved in several ways. One method is to coat the pattern initially with a gel coat. The gel coat is a thixotropic

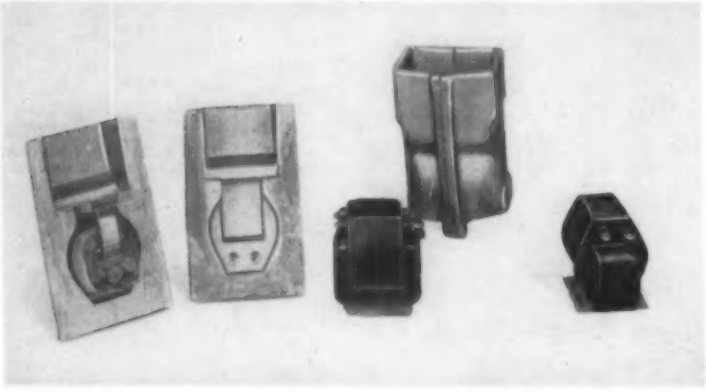

FIG. 2: Sand-cast aluminum mold for the encapsulation of the transformer shown in the photograph. Note rough surface on the part resulting from production in a mold made by this technique.

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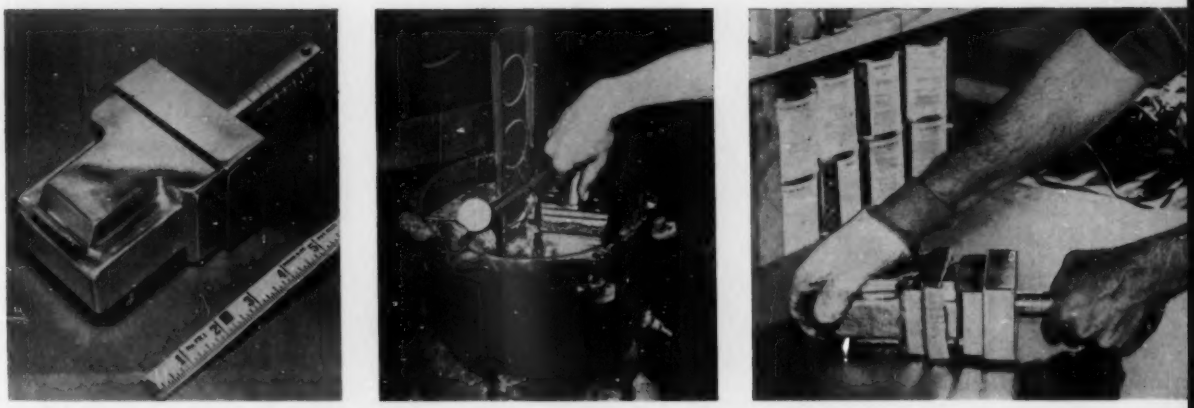


FIG. 3: Steps in the production of a dipped metal mold: Left: metal master pattern; center: master pattern dipped into low-melting mold alloy; and right: removing dipped metal mold.

coating designed to be dipped onto the pattern in a relatively thin coating and to stick onto a surface without flowing. These coatings cure to a hard, smooth surface. They cure uniformly and, because they adhere firmly to the pattern's surface, they form a good base for the casting compound which forms the completed mold.

Another problem in making epoxy molds using resins with fillers with high settling rates or resins with low filler concentrations is that surface wrinkling can occur. In these cases, it is best to increase the filler concentration as much as possible. Use several fillers to check settling rates, then use the filler with the lowest settling rate.

Molds of other plastics

Other plastics which can be used for molds are vinyl plastisols, room temperature-vulcanizing (RTV) silicone rubbers, various hot-melt materials such as cellulose acetate butyrate and ethyl cellulose, and meltable polyethylene. Method of manufacture is similar to that used for making epoxy molds. The mold material, be it hot-melt or curable resin, is poured around the pattern and allowed to harden. Major advantages of the technique are convenience and speed in making molds.

The main disadvantage arises from the lack of rigidity in the mold material, which often means that close dimensional tolerances cannot be held. In some cases, this may not be important. However, where continuous close dimensional control is required, rigid molds are more reliable. Another problem with elastomeric materials is that mold life may be limited.

An advantage in some cases is the fact that most of these materials can be used without the assistance of mold release agents. This is true where the mold material surface is by nature waxy or greaselike, where the mold may be flexed to release the part, or where the shrinkage of the embedding compound is high, such as occurs with certain polyester resins.

Short run molds

When a mold is needed in a hurry and where a small number of parts are to be made from a mold, it is often convenient to cut the mold from Teflon or polyethylene sheet stock (for rectangular molds) or tubing (for cylindrical molds). This type mold cannot be used where close dimensional tolerance is required or for long runs, since both Teflon and polyethylene tend to distort easily. In this type mold, no mold release is required.

Axelrad has described another interesting method to make a short run mold conveniently and rapidly (4). This technique involves pressing a metal pattern into stacked, gummy, uncured Neoprene sheets to form a cavity and then curing the impression with the pattern in place. These molds are suitable for use with any casting resin that is compatible with Neoprene. Although tolerances cannot be held to those possible with matched metal molds, a reasonable degree of precision is possible.

For maximum dimensional accuracy and finish, a steel master pattern should be used in the above technique. Other materials, such as aluminum or a heat-resistance plastic, can often be used for simple

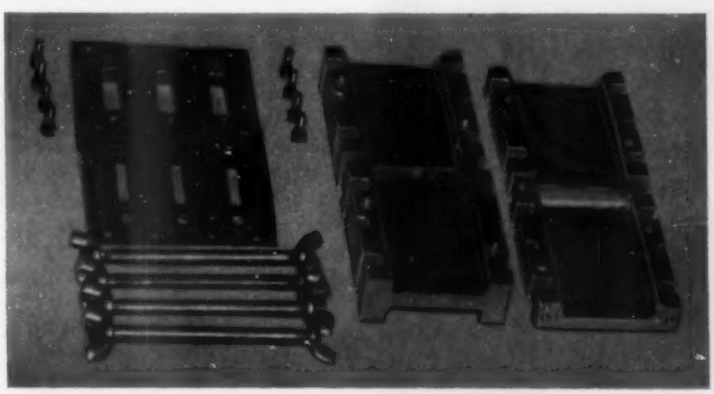


FIG. 4: Mold simplification is possible through the use of cast epoxy molds. Simple epoxy mold on right replaces complex machined metal mold on left. Note simple clamps (bottom, left) used for epoxy closure.

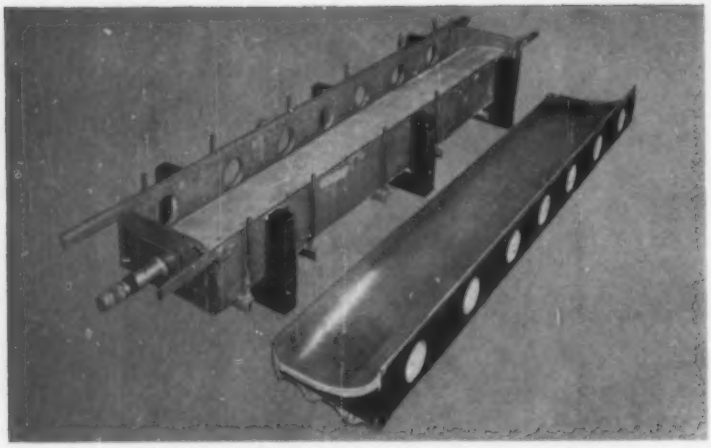


FIG. 5: Mold used for the manufacture of a large embedment in urethane plastic foam. Heavy metal reinforcement is required in order to contain the foaming pressure. Note uniformly spaced pouring holes.

patterns. Wood is unsatisfactory; it compresses during fabrication of mold and accuracy is lost. Copper and brass are undesirable, since the Neoprene rubber sticks to the pattern, thereby producing a rough mold surface.

One- or two-piece molds can be made, depending on the complexity of the cast part. One-piece molds are used for all parts having one flat side on which pressure can be exerted. They are formed by forcing the pattern into a stack of uncured Neoprene sheets, cut to fit inside a pressing chamber. The pressing chamber is a shallow box with removable top and bottom plates machined to fit inside the box. The chamber containing the pattern and the Neoprene sheets is placed in a press, heated to 300° F., and pressed at 800 to 1500 p.s.i. for 20 minutes. After cooling, the cured Neoprene mold is ready for use.

FIG. 6: Fixture used for dipping several molds simultaneously. Dipping is used to apply mold release agents.

Molds for foam embedments

Although the same molds can be used for casting foams as for casting other embedment materials, there is one major difference in mold design to be considered. In casting foams, high pressures can be generated during the foaming reaction. Thus, the mold must be strong enough to resist these pressures. Pressures will vary from foam to foam, and with the extent to which the volume expansion is restricted in a mold. Especially high pressures can be generated by one-shot urethane compounds, compounds which are directly reacted to completion in the mold. Rigid, ½-in.-thick epoxy molds have been distorted and cracked by the pressures generated in a urethane foaming reaction.

Although the pressures can be controlled somewhat by formulation of the foaming material, accurate control of the mold-volume-to-foam ratio and control of mold temperature and venting are the chief methods for controlling the mold pressure.

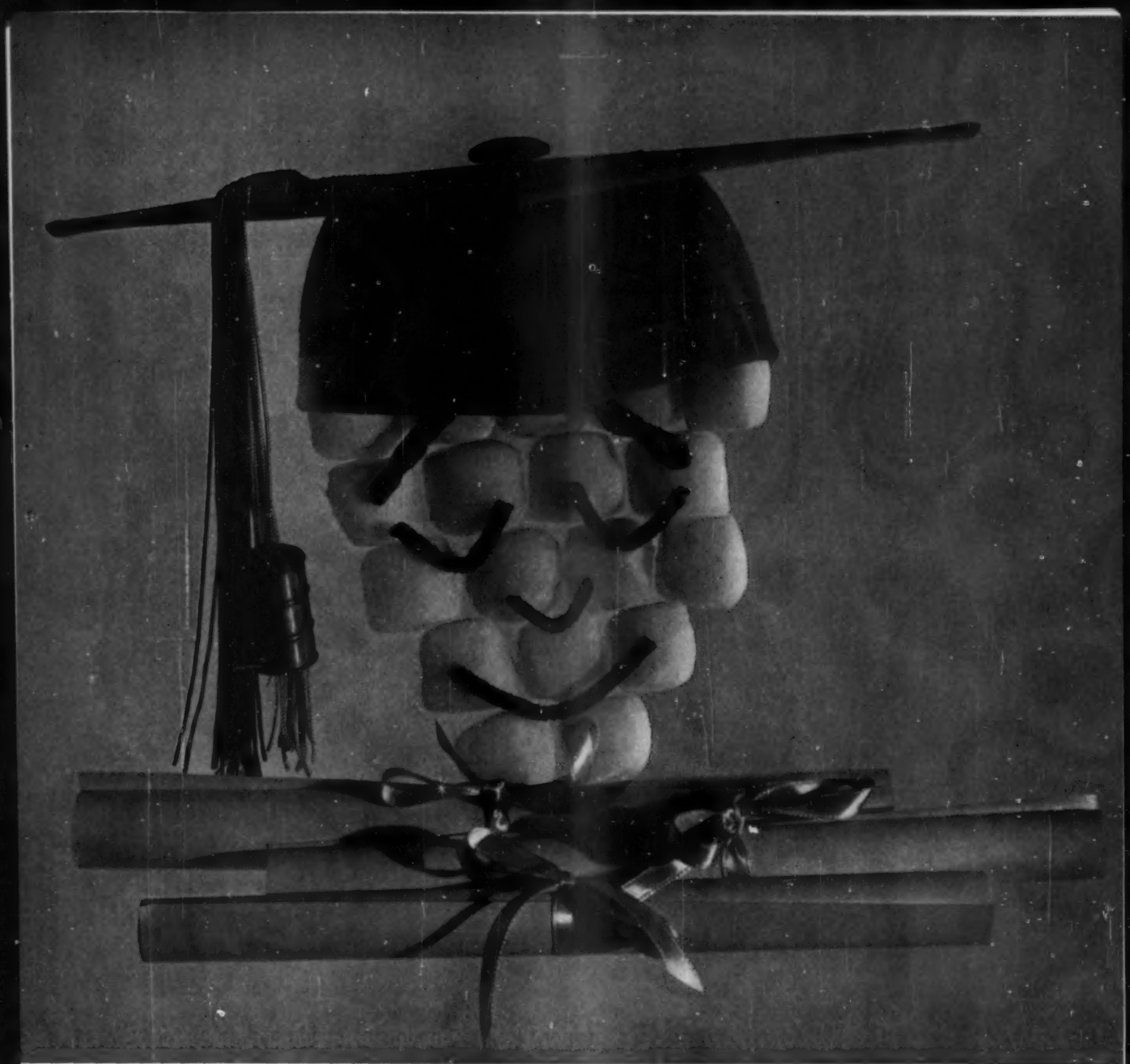
For example, mold pressure can be minimized by using open molds. This has disadvantages, in that the foam may expand over the outside of the mold and adjacent areas if not closely controlled.

Rather than use a completely open mold, it is far better to partially restrict the foam. This promotes the formation of small cells, a uniform cell structure, and uniform density. If a foam is expanded without any restriction, there will often be irregularities and even cavities in the foam structure. The restricted mold should have small holes (risers) through which excess foam can escape and which can be trimmed after the reaction. It is also necessary to have a mold-filling hole for pouring the foam. The size of the filling hole required will depend on the viscosity of the foam material when it is poured and on the foam reaction rate. Some foams react very rapidly and are viscous, thus requiring fairly large filling holes. If filling holes are not too large, they can also be used as risers. Although a second pouring can be done if insufficient foam has been generated by the first charge, this should be avoided wherever possible for two reasons: 1) the first pouring, unrestricted, may result in a non-uniform cell structure and foam density, and 2) foam-to-foam adhesion, and foam strength, is not as good as that of a single poured foam.

Figure 5, above, illustrates a well-designed mold for making a large part from urethane foam. Notice the mechanical mold reinforcement, and the several uniformly spaced pouring holes in the mold. Here, pouring through several of the holes simultaneously gives a more uniform cell structure than could be obtained by pouring in one end or in the middle. Most of the pouring holes are quickly closed after the foam is poured; a couple are left open to act as risers.

Pattern and mold design

In all the mold-making methods using master patterns, certain design considerations are useful. First, the mold should have a draft angle of at least ¼°, and up to 1° if possible. This facilitates removal of



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the casting from the mold. It is also important that the master pattern have a highly polished surface. Any pattern imperfection will be transferred to the mold, and thence to all of the molded parts. It is wise to design the mold so that the pattern and castings may be conveniently ejected from the mold with a simple ejection device such as an arbor press.

In choosing a material for the master pattern, remember that steel is hard and not as readily dented as aluminum. On the other hand, aluminum will not corrode as does steel if it is not properly cared for. Other materials can be used for patterns, but steel and aluminum are most popular.

It is often possible to make additional epoxy patterns from the first mold made from a metal pattern, economically increasing the number of patterns available and the rate at which a large number of molds can be rapidly made. It is not wise to make patterns from every additional mold made, since shrinkages will be cumulative. For this reason, only the first mold made from a metal master pattern should be used for making additional epoxy patterns.

In designing the mold, some type of quick clamping device should be incorporated to facilitate mold assembly and disassembly; resin spillage or leakage around screw fasteners would cause them to break during assembly or disassembly. Other mold design considerations involve planning for easy gasketing of the part to be embedded and clamped into the mold, for conveniently seating the part into the mold, and for adequately evacuating the air from the mold before the curing operation.

Mold release agents

Because of the adhesive properties of some resins, particularly epoxies, casting operations are complicated by mold release problems. The release agent which can be used will depend on the mold and the material being poured into the mold. It may be necessary to experiment for a given application. The most common release agents used are the silicones, liquids, and greases. Grease release agents are often difficult to apply uniformly, particularly in corners. Liquids, as supplied, are sometimes higher in viscosity than is desired. If used as supplied, the liquid may form a coating on the inside of the mold which, after successive curing operations, will degrade the mold surface. It is quite difficult to remove this coating from the mold. To help avoid this problem it is sometimes desirable to dilute the liquid with suitable diluents. In addition, several low-viscosity, silicone-based liquid release agents are available. These lend themselves to dip coating a large number of molds at one time.

Other types of release agents can also be used. Carnauba wax in naphtha is easy to use and gives a good surface. Such solutions are normally not useful above 180° F. Above this temperature, up to 200° F. and slightly above, Damar wax dissolved in naphtha can be used. However, for higher temperatures, low-viscosity, silicone liquid releases are required.

Other methods of mold release include the use of Teflon coatings on the mold. Such coatings cannot normally be used on plastic molds due to the high sintering temperatures of the Teflon. These coatings tear and fail quite easily in handling and care must be exercised. Other types of coatings which can be used are polyvinyl alcohol film and vinyl dispersion coatings. These, too, are difficult to use.

One other point which should be mentioned is that it is especially important to coat the pattern or mold very thoroughly for the first few cycles of use, since there is often observed what might be called a break-in period during which parts are more difficult to separate than they will be after the mold or pattern has been used several times. Thus, it is wise to use an excess of mold release for the first few applications.

FIG. 7: Equipment used for the ink stamping of identifying masks on encapsulated electronic components. Fixtures shown in photo are used to position parts to facilitate stamping.

Fixtures

Mold stripping fixtures. An arbor press can be used for stripping parts from simple molds. If the mold is complicated or if the production volume is very high, an air-actuated ejection mechanism coupled with automatic feeding and positioning of the mold is more desirable. Mold stripping is facilitated when a one-part mold is used which has a simple knock-out ejection pin arrangement as opposed to a built-up mold which must be torn down.

Fixturing for mold release applications. If the mold has an irregular surface, manual application may be required if paste-type release agents are to be used. This is not desirable. With liquid release agents, an atomizing or a dipping fixture may be set up for applying the release agent. Since uneven spray application of mold release reflects itself on the surface of the finished part, dipping is more satisfactory.

Two things are critical in design of a mold release dipping system. First, arrangements must be made to control viscos- **(To page 168)**

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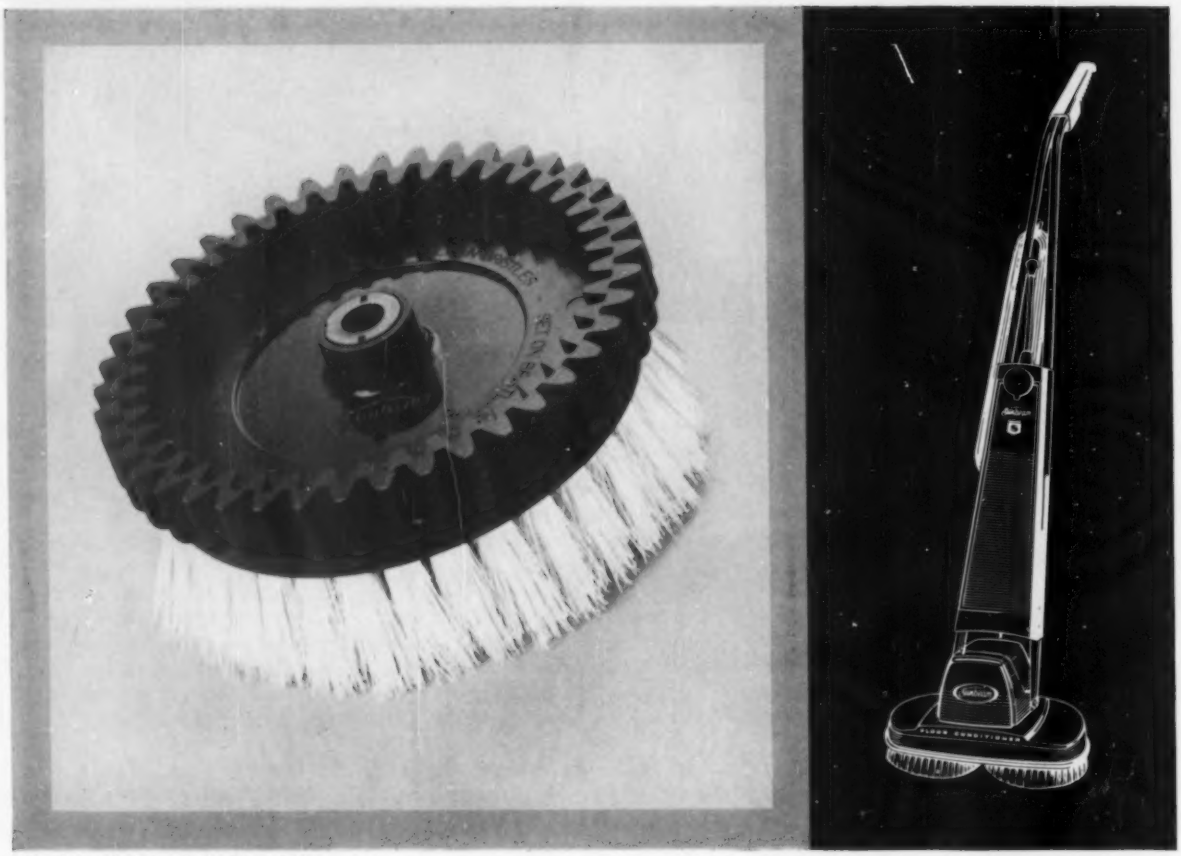

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PLASTICS* TECHNICAL SECTION

MATERIALS • PROPERTIES • TESTING METHODS AND INSTRUMENTATION • STANDARDS • CHEMISTRY

Effect of physical treatments on the stability of polyamides

By M. M. Epstein† and C. W. Hamilton‡

Physical treatment by itself is not sufficient to heat stabilize nylon effectively. The deterioration of an unstabilized piperazine copolymer clearly demonstrates that the filaments are still susceptible to thermally induced oxidation, which occurs primarily in the amorphous regions. However, combining the proper physical treatment (quenching and drawing) with the proper additive results in a major improvement in stability.

Many forces influence the deterioration of organic polymers such as polyamides. Chemical reactions, exemplified by hydrolysis, crosslinking, and photo-initiated oxidation, have been identified as the cause of gross deterioration of nylon's mechanical properties. To a limited extent, protection against these undesirable reactions can be obtained by the incorporation of certain additives, such as antioxidants and ultra-violet-light absorbers. Actually, additives do not give complete protection, as demonstrated by nylon's instability to natural weathering conditions.

Poor mechanical properties, very similar to those encountered in aged materials, can also be induced in nylon by producing specific crystalline structures in a fabricated sample. For example, spherulites in nylon-66 result in higher yield points (1).[1] In another polymer, polyethylene, spherulites adversely affect impact strength (2). The number and size of spherulites are closely related to the way in which the sample has been cooled during fabrication; slow cooling resulted in large spherulites, whereas under conditions of fast cooling (quenching at low temperatures) spherulites did not form or were so small as to be below the limit of resolution of the instrument (3). The physical properties of polyamides are also affected by the ratio of crystalline to amorphous material (4).

The choice of fabrication procedures will determine the amount and type of crystallinity. It should be possible to control processing conditions such as quenching, annealing, and externally applied orientation (5-7) either to produce internal changes that normally occur during aging over extended periods of time or, conceivably, to produce a more stable crystalline arrangement, which would result in improved retention of mechanical properties during aging. Quenching and cold drawing, for example, have been suggested as two possible methods to protect Fluorothene, a crystalline polymer, from heat embrittlement (8).

Treatment of Zytel 3606

Despite the presence of stabilizers, aging of Zytel[2] 3606 filaments causes some embrittlement. The degree of deterioration was estimated by determining the loss in

*Reg. U. S. Pat. Off.
†Battelle Memorial Institute, Columbus, Ohio.
‡Continental Can Co. Inc., Chicago, Ill.
[1]Numbers in parentheses designate references at end of article, p. 177.
Based on a paper presented at the SPE 17th Annual Technical Conference, Washington, D. C., January 1961.

[2]Tradename of E. I. du Pont de Nemours and Co. Inc.

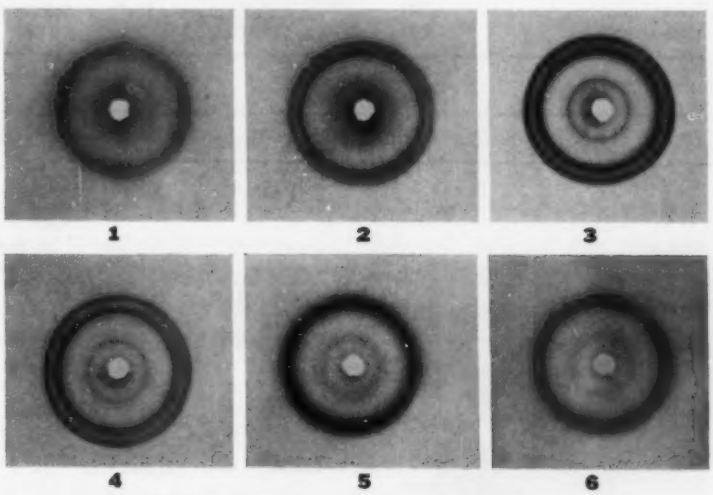


FIG. 1: X-ray diffraction photograms of annealed Zytel 3606, Filaments 1 to 6. (See Table II, p. 114, for treatments.)

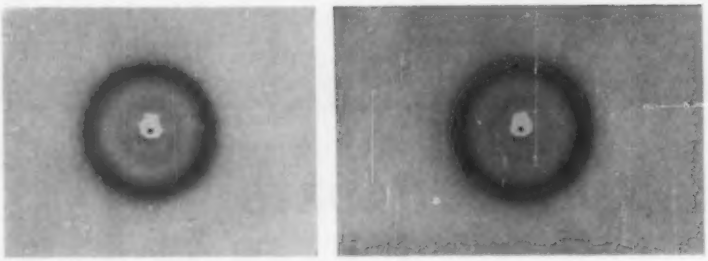


FIG. 2: X-ray diffraction photograms of unaged (shown at left) and aged nylon 66/610/PIP-10 (Sample 2610).

tensile strength and elongation, and increase in yield point during outdoor aging (Table I, below); during accelerated heat-aging test (Tables II, below, and III, p. 119).

X-ray diffraction photograms (Fig. 1, p. 113) of the aged and unaged filaments showed that there was no change in the degree of orientation but that aging produced a marked increase in the degree of crystallinity. The "as extruded" specimen (Filament 1) was amorphous and without any preferred orientation. Heat aging at 140° C. caused it to become very crystalline (Filament 2). Annealing at 200° C. caused an increase in crystallinity but, in addition, produced increased rotational ordering of the molecule along its main axis into a more ordered, fixed position. Heat aging produced no change in the X-ray diffraction pattern of this filament. The annealed and re-extruded specimen was amorphous and exhibited lateral disorder; heat aging produced a very crystalline material (Filament 6), similar to Filament 2. However, Filament 6 had a lower degree of lateral ordering than did Filament 2. Aging at 140° C. caused some ordering in which the (110) and (020) rings became well resolved, but not so sharp and distinct as in the case of the annealed, aged filament (Table II). A higher degree of ordering is evidenced by the marked sharpening of the outer doublet rings, and by an increased separation of the intermediate-ring doublet. Annealing produced a stiffening of the filament, accompanied by a reduction in tensile strength and elongation (Table III). However, the properties of the annealed filament did not change appreciably during heat aging, in contrast to the considerable change that took place in the properties of the untreated filament. Surprisingly, the annealed, re-extruded filament exhibited an irreversible loss of tensile properties and deteriorated more severely than the other filaments.

These experiments indicated that tensile embrittlement, as induced by aging, was a function not only of the degree of crystallinity, but also of the degree of ordering. Since annealing is a well-known method for changing the degree of molecular ordering, filaments of Zytel 3606 were annealed in silicone oil at other temperatures for 10 min. and then slowly cooled to room temperature over a period of several hours before removal from the silicone oil bath. The most stable filaments were those annealed at 200° C., the highest temperature used (Table IV, p. 120).

Although annealing at 200° C. produces a stable polymer, it has the undesirable effect of initial stiffening. Consequently, other physical processes were examined, such as quenching and drawing. For example, three filaments were extruded under a variety of different conditions: 1) no special treatment, 2) drawn during extrusion, and 3) drawn and quenched (0° C.) during extrusion.

The three filaments were then aged for 8 days at 140° C. and the changes in tensile properties recorded (Table IV). Although superficially the differences appear to be slight, the drawn **(To page 119)**

Table I: Properties of nylon filament before and after outdoor aging for 18 months in Ohio

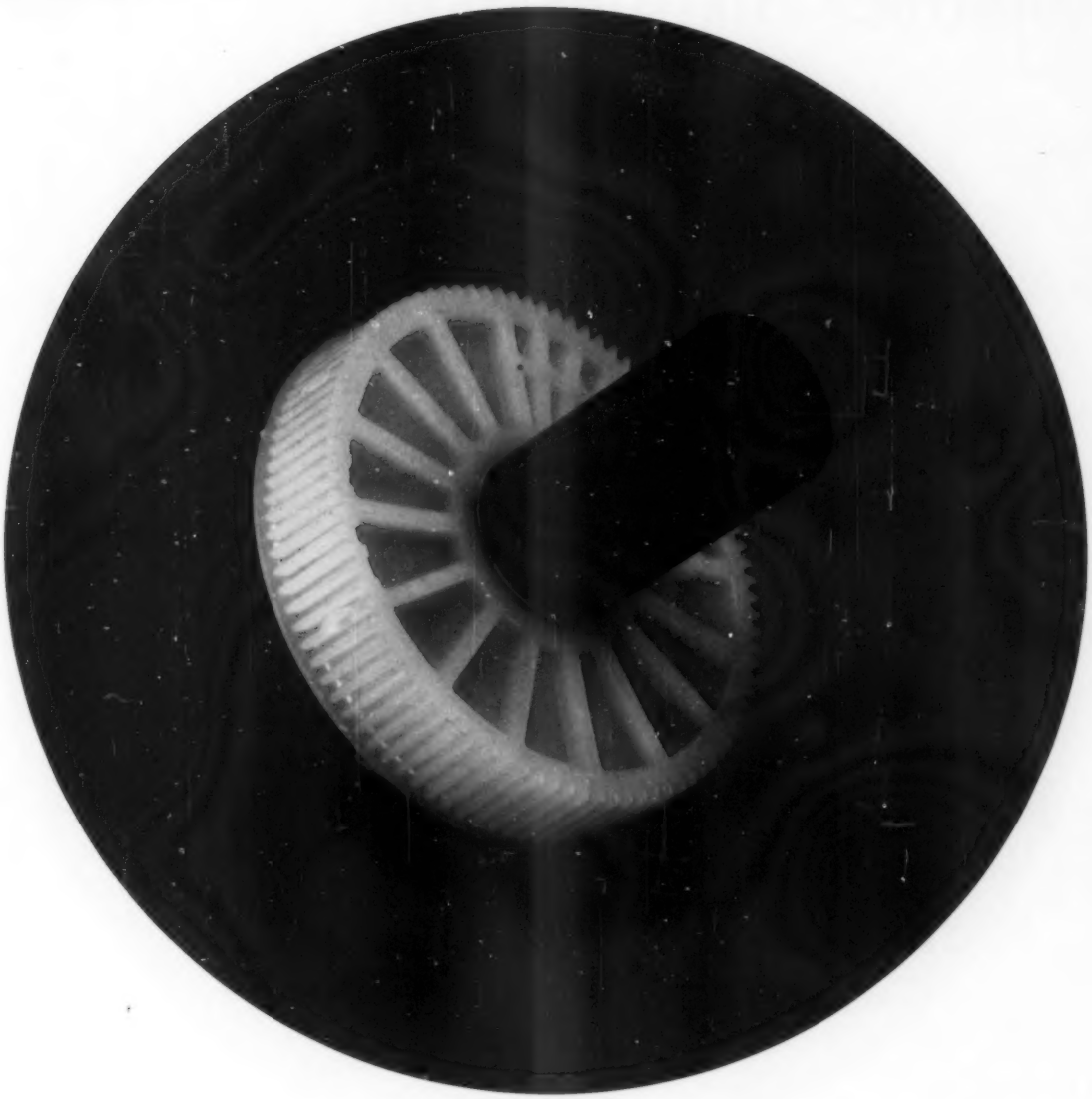
	Tensile strength	*Elongation*	*Yield strength*
	p.s.i.	*%*	*p.s.i.*
Before aging	14,500	362	5,000
After aging	7,900	160	7,000

Table II: X-ray diffraction characteristics of heat-treated Zytel 3606 filament

Filament number	*Heat treatment*	*Amorphous portion*	*Crystalline portion*	*Crystallinity by ring sharpness*	*Doublet-ring separation in mm.*	*— Interplanar spacings of rings in Å. Inner ring*	*Outer ring*
1	As extruded	Medium strong	0	5	0	4.15	4.15
2	Filament 1 aged 8 days at 140° C.	Very faint	Strong	2	1.7	4.28	3.74
3	Filament 1 annealed at 200° C. for 10 min.	Faint	Strong	1	2.5	4.34	3.64
4	Filament 3 aged 8 days at 140° C.	Faint	Strong	1	2.5	4.34	3.65
5	Filament 3 re-extruded	Strong	0[a]	5	0	4.10	4.10
6	Filament 5 aged 8 days at 140° C.	0	Strong	2	1.6	4.32	3.83

[a] No ordering of chain; some ordering of the repeat distance along chain occurred.

Plaskon NYLON 6..LIGHT WEIGHT, HIGH IMPACT STRENGTH!



This windshield wiper gear must turn thousands of times without lubrication . . . resist heat and abrasion . . . withstand extreme changes of climate. It comes through with flying colors — because it's molded of Plaskon® Nylon 6.

Plaskon Nylon molding and extrusion compounds offer all the well-known nylon properties: toughness, light weight, high impact and tensile strength, resistance to abrasion, corrosion and heat. But they also add several advantages all their own: better dimensional stability due to lower shrinkage, fewer voids during molding, greater impact strength. Plaskon Nylon can be molded in thin (up to .030″) transparent sections, takes color easily before or after molding, and molds at lower cylinder temperatures. Write us for full technical data.

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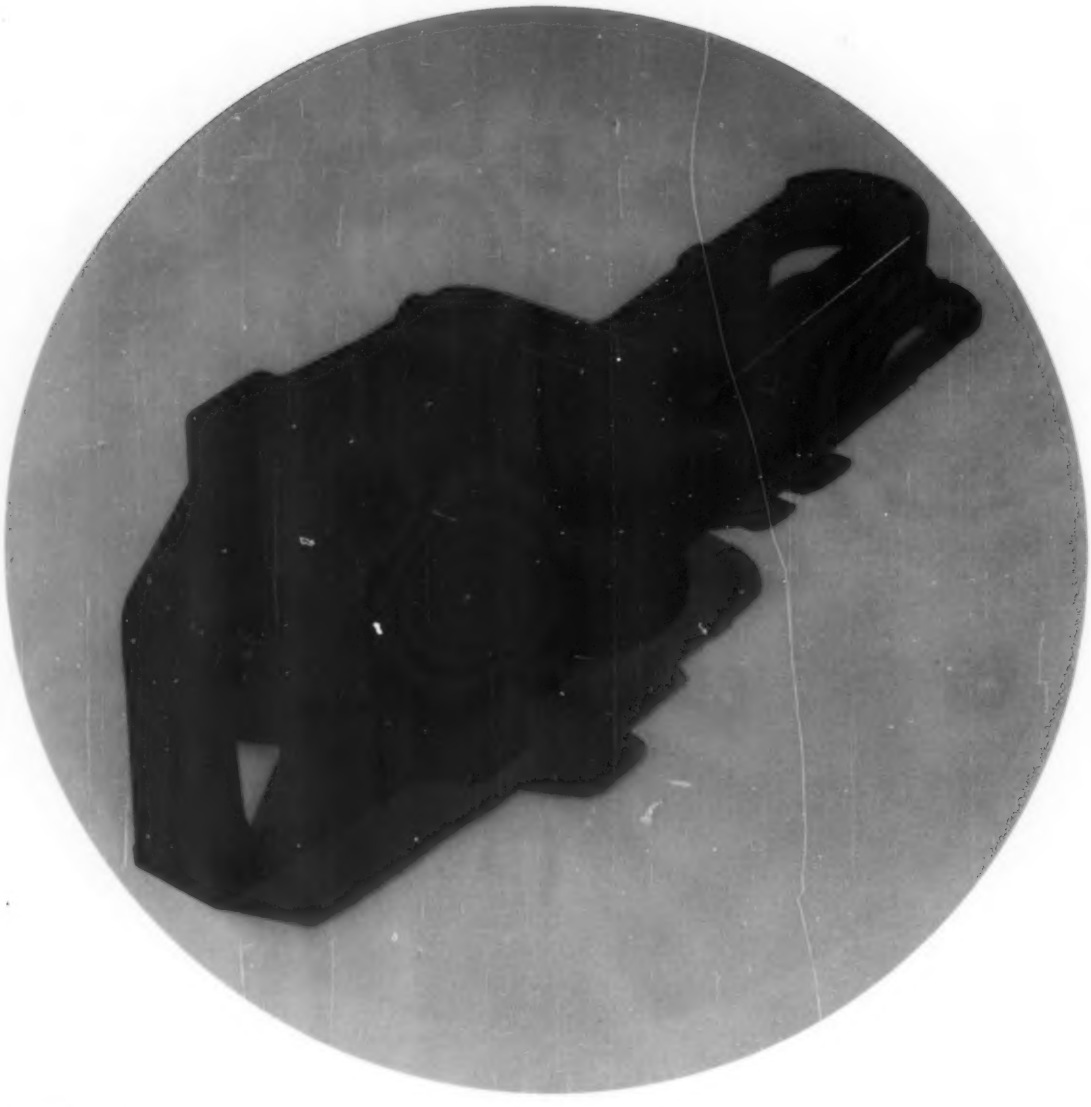
Plaskon POLYESTER RESINS SPEED PRE-MIX MOLDING



Rapid molding of parts (such as this automobile heater housing, as well as others with varying thicknesses and intricate contours) is facilitated by Plaskon® Polyester Resins for pre-mix molding. Ease of molding and excellent resistance to heat and common solvents, add to the usefulness of these hard-working materials.

Plaskon Polyester Resins were the first to be specifically designed so that molders could use their own glass or other reinforcements, fillers and catalysts in compounding molding materials. The pre-mix method offers fast-molding cycles at considerably lower cost than conventional preform or mat-molding of reinforced polyester resin laminates. Write for technical data.

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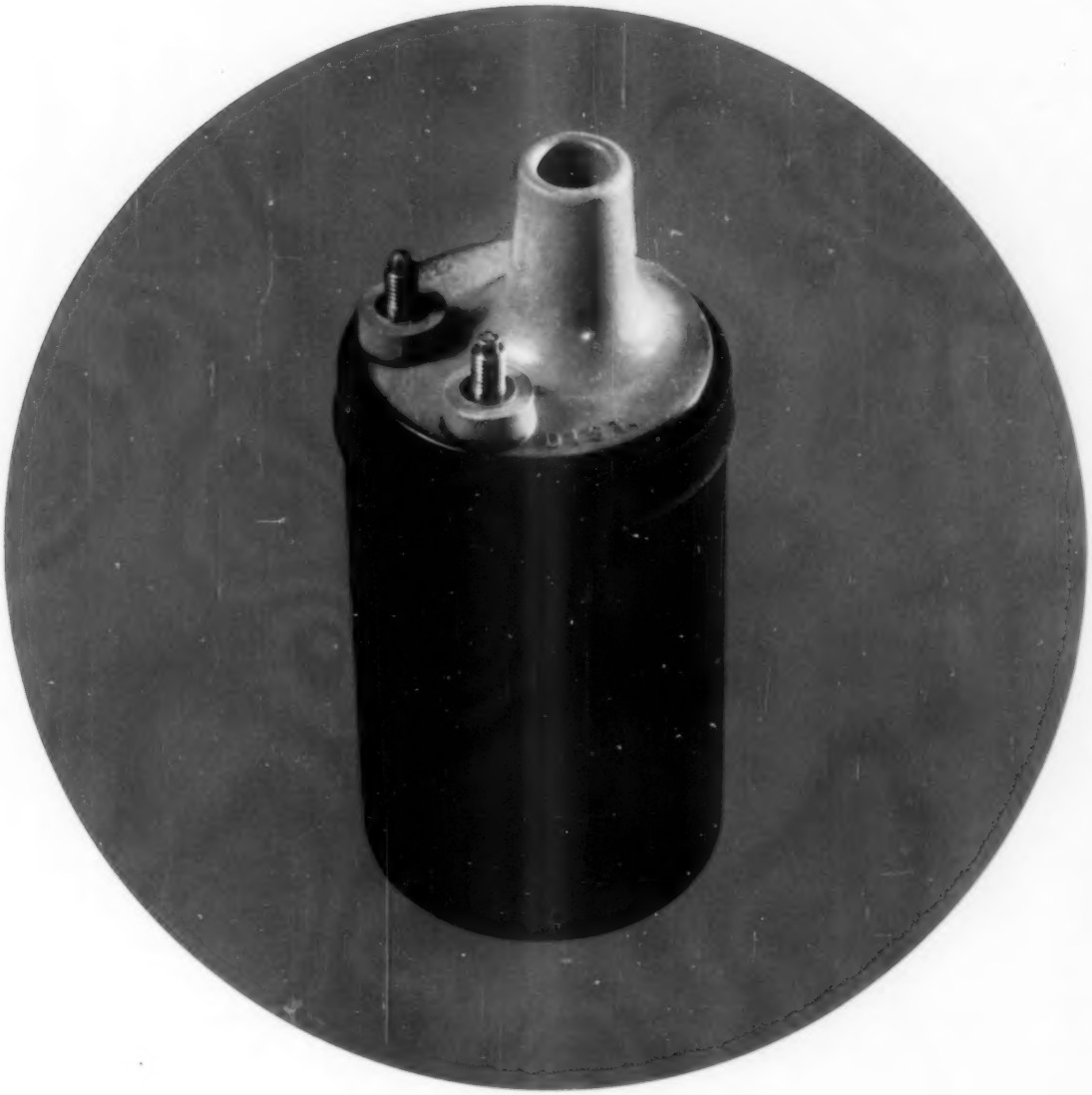

Higher compression ratios, 12-volt electrical systems, added to the auto industry's increasing need for reliability and longer service life, all indicate the need for an insulating material of the quality of Plaskon Alkyd Molding Compounds for ignition coil towers.

Plaskon Alkyds resist arc-over better than any other thermosetting material. They provide higher dielectric strength and maintain dimensional stability at extremes of heat and cold, moist and dry temperatures encountered in the engine area. Alkyds provide trouble-free service longer.

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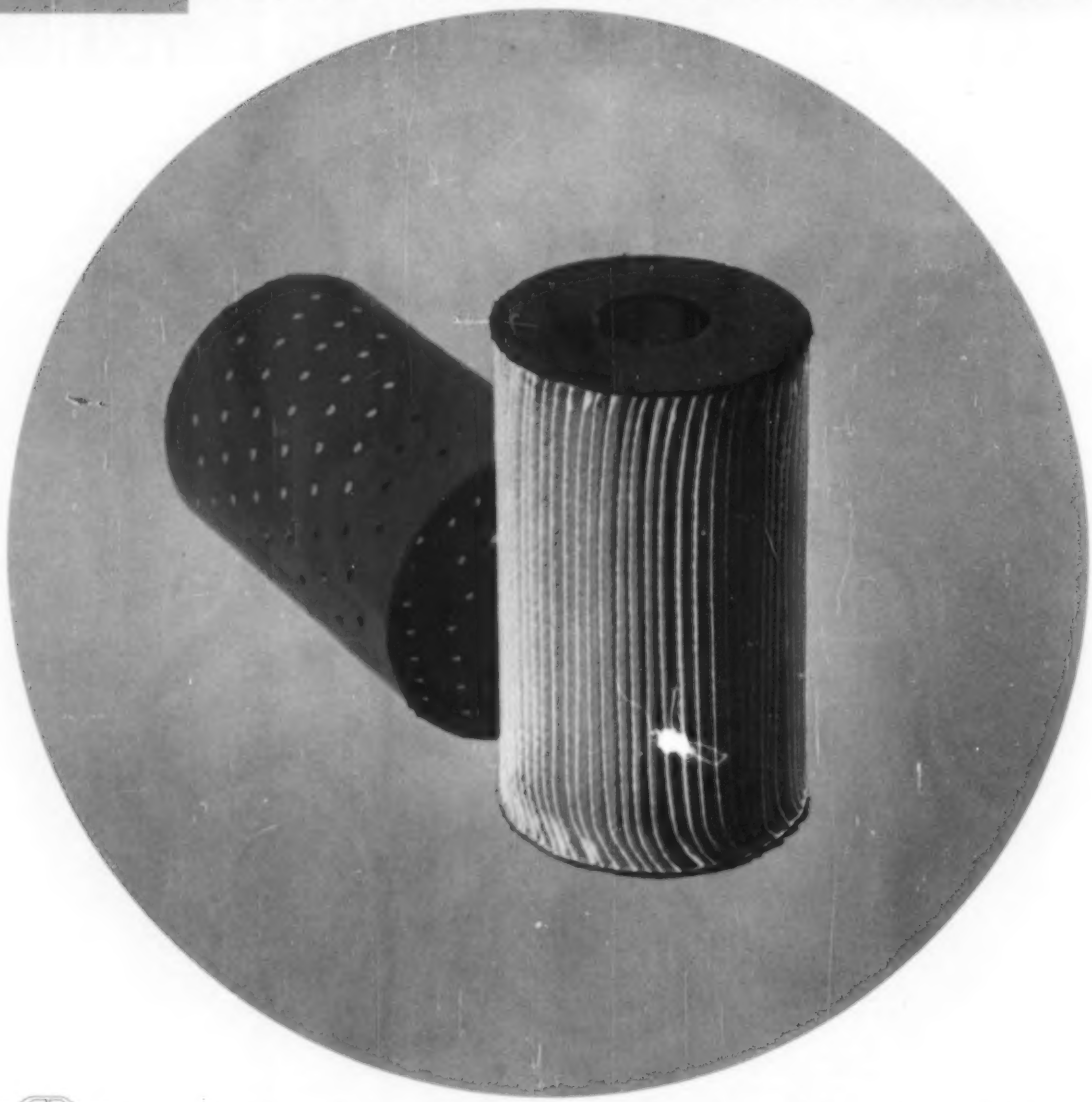

Impregnation with Plaskon® Phenolic Resins increases the wet and heat strength of this oil filter cartridge — making it possible for the paper liner to withstand a continuous flow of oil as it filters corrosive impurities.

Water, alcohol, oils, greases, mild acids and common solvents do not adversely affect Plaskon Phenolics. These versatile materials have excellent heat resistance (up to 600°F when laminated with glass cloth). They undergo no marked change at freezing temperatures. Where extreme chemical resistance is required, special grades are available.

Excellent electrical properties have resulted in the wide use of Plaskon Phenolic Resins in battery separators, as well as other bonded paper and fiber products. If you are looking for toughness, dimensional stability and good resistance to heat, water and wear, write us for full performance data on Plaskon Phenolic Resins.

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specimen seems to be somewhat more stable, both in respect to tensile strength and elongation. In addition, the loss in initial properties because of drawing are not very severe. It is questionable whether the ice water quench contributed very much to the stability of the filament. Quenching by itself was also studied, and the stability of the polymer was found to be quite dependent on the quench temperature (Table IV). Filaments were extruded and quenched at temperatures from 100° C. (boiling water) to —70° C. (dry-ice acetone mixture). Generally, the most serious deterioration occurred at the lowest temperature, —70° C., with both tensile strength and elongation decreasing. At 100° C. elongation was retained, but tensile strength declined. Except for elongation, which increased as quench temperatures were lowered, the initial properties of the filaments were not affected by the quench temperature.

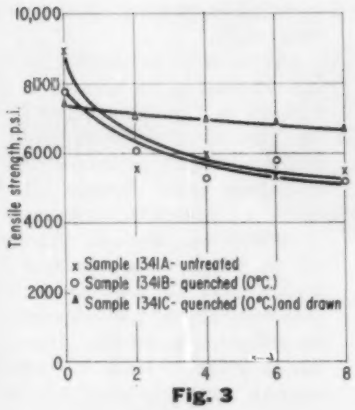

Fig. 3

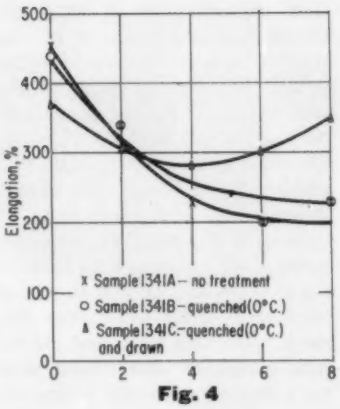

Fig. 4

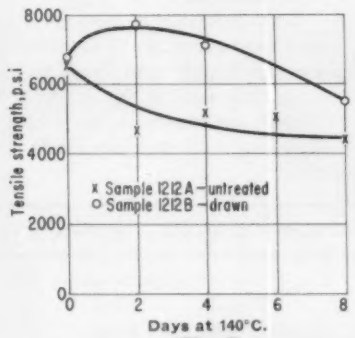

Fig. 5

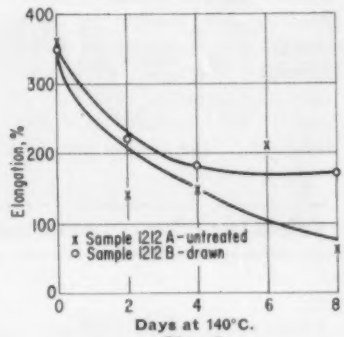

Fig. 6

FIGS. 3 TO 6: Effects of heat aging on the properties of physically treated nylon 66/610-PIP-10 filaments (See Table V, p. 120).

Treatment of nylon 66/610/pip-10

This polyamide was prepared by the melt condensation of three nylon salts, 66 (hexamethylene adipimide), 610 (hexamethylene sebacimide), and pip-10 (piperazonium sebacate), in a 35/30/35 weight ratio. The polymer was developed for the Signal Corps for possible use as a wire jacket; its outstanding characteristic is exceptional heat stability (9). For the intended application, the polymer requires additional protection, but unlike the more common polyamides, it does not readily respond to antioxidants and other known chemical stabilizers (10). During accelerated aging, monofilaments undergo considerable embrittlement, as shown by sharp declines in tensile strength and elongation, and a significant increase in the yield point. Because of the poor response to chemical stabilizers, it was assumed that crystallinity was highly critical in the aging process of this nylon.

Typical of its response to accelerated aging, in most cases the greatest deterioration occurs in the first two days of aging at 140° C., indicating that the changes which do take place are limited in extent and occur readily at the elevated temperature. The decline is common to stabilized and unstabilized materials, as if rapid crystallization produces the largest change that is observed within the initial aging period. The deterioration that takes place in the final 6 days at 140° C. probably is caused primarily by thermal oxidation.

Gross changes in crystallinity were observed in a filament of this nylon stabilized with sym-di-beta-naphthylphenylenediamine (sample 2610). The X-ray diffraction photograms in Fig. 2, p. 114, illustrate the extent of crystallization. The changes in tensile properties of this composition during aging typify the best results obtained with additives: tensile strength dropped from 9000 to 6150 p.s.i., elongation from 380 to 250%, the yield point increased from 2500 to 4200 p.s.i. And

Table III: Properties of annealed Zytel 3606 filaments

	Initial properties			*Properties after heat aging 8 days at 140° C.*			
Heat treatment	*Tensile strength*	*Yield point*	*Elongation*	*Tensile strength*	*Yield point*	*Elongation*	*Weight loss*
	p.s.i.	*p.s.i.*	*%*	*p.s.i.*	*p.s.i.*	*%*	*%*
None	12,400	3,900	456	7,900	7,700	380	1.99
Annealed at 200° C.	10,000	7,900	386	9,200	8,100	380	1.08
Annealed at 200° C., then re-extruded	8,800	5,500	336	7,300	7,200	154	0.64

since crystallization, in some unknown manner, seems to be the primary cause of mechanical degradation, a study was made of the effect of quenching and drawing on the heat stability of extruded monofilaments. For example, nylon 66/610/pip-10, stabilized with phenothiazine and a catechol-formaldehyde resin (Sample 1341), was subjected during extrusion to quenching in ice water, as well as partial orientation in ice water. The filaments were heat aged, and the results compared with similar data for a filament untreated during extrusion. Figures 3 and 4, p. 119, illustrate the changes in tensile strength and elongation of all three filaments. There was no apparent difference between the "as extruded" and quenched specimens. However, the oriented and quenched filament was considerably more stable.

The effect of orientation by itself, eliminating the quench, is illustrated in Figs. 5 and 6, p. 119. The polymer in this case was stabilized with the catechol-formaldehyde resin alone (Sample 1212). Again, a considerable improvement in stability was obtained, although not as great as was observed in Sample 1341 C. Absence of the phenothiazine may partially explain the difference in stability, although this is unlikely. Table V, below, compiles other important data for these filaments.

Up to this point in the work, two facts were apparent: 1) Crystallization significantly contributed to the deterioration of this polyamide, and 2) physical treatment, particularly quenching and drawing, could be applied to enhance the polymer's resistance to aging. Since these data shed no light on the nature of destructive crystallization nor on the mechanism by which it was retarded, an experiment was devised to clarify these points. The polyamide selected for examination (Sample 1563) had a molecular weight of 14,300 and contained no antioxidant. The decision to use an unstabilized material may be questioned because of the oxidative degradation that occurred. However, it was desired to study physical treatment as the only applied stabilizing force. Three filaments were extruded:

1563 C: This filament was allowed to cool slowly by itself in air.

1563 B: Drawn during extrusion and air cooled. **(To p. 122)**

Table IV: Effect of various treatments on the tensile properties of Zytel 3606 filaments

Filament	*Treatment*	*Initial properties* — *Tensile strength* p.s.i	*Yield point* p.s.i.	*Elongation* %	*Properties after 8 days at 140° C.* — *Tensile strength* p.s.i.	*Yield point* p.s.i.	*Elongation* %
		Effect of annealing					
3606	None	12,000	5,400	470	8,600	6,600	350
3606-1	Annealed at 160° C.	11,900	7,900	380	7,500	7,500	276
3606-2	Annealed at 180° C.	8,600	7,700	364	7,800	7,800	320
3606-3	Annealed at 200° C.	9,000	8,600	370	8,200	8,000	356
		Effect of drawing					
3606-1	None	12,000	5,400	470	8,600	6,600	350
3606-2	Drawn during extrusion	11,800	4,300	450	9,700	6,800	400
3606-3	Drawn and quenched in ice water during extrusion	10,400	4,600	420	9,200	7,300	360
		Effect of quenching					
3606	None	11,600	5,400	410	8,500	7,500	325
234-2	Extruded into boiling water	14,100	4,600	386	6,400	5,700	391
267-A	Extruded into water at 50° C.	9,900	3,500	408	7,300	2,600	368
267-B	Extruded into ice water	10,000	3,500	426	7,000	2,500	344
611	Extruded into dry-ice acetone mixture	11,300	3,400	440	6,800	6,400	224

Table V: Extrusion conditions for nylon 66/610/PIP-10 filaments (see Figs. 3 to 6)

Filament	*Treatment during extrusion*	*Molecular weight**	*Filament diameter* in.	*Extrusion temperatures* — *Barrel* °C.	*Die* °C.
1341 A	None; air cooled	10,600	0.045	154	182
1341 B	Quenching (0° C.)	10,600	0.043	154	182
1341 C	Quenching (0° C.) and orientation	10,600	0.032	154	182
1212 A	None; air cooled	10,500	0.069	160	177
1212 B	Orientation	10,500	0.030	169	177
1563 C	None; air cooled	14,300	0.054	149	193
1563 B	Orientation	14,300	0.030	149	193
1563 A	Quenching (0° C.) and orientation	14,300	0.030	149	193

*Determined by intrinsic viscosity measurements.

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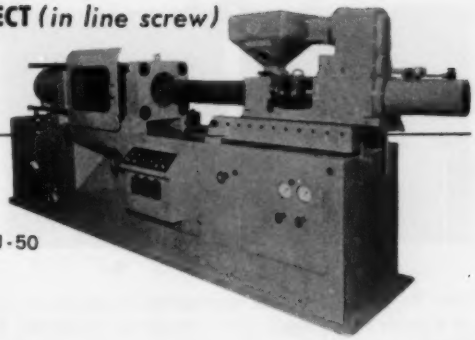
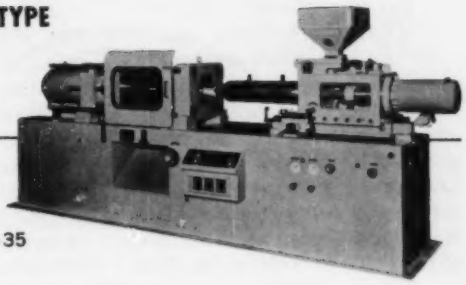
■ SCREW JECT *(in line screw)*



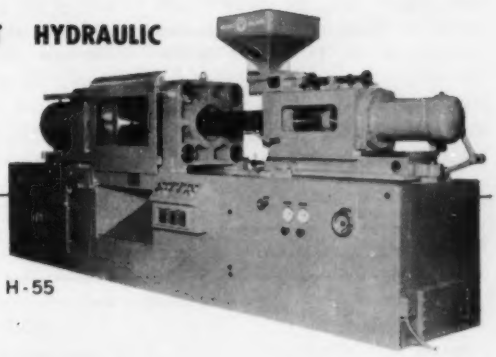
SJ-50

■ PLUNGER TYPE



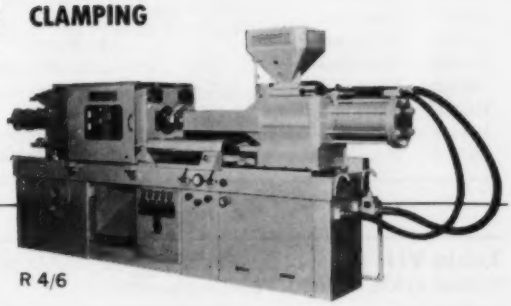
H-35

■ STRAIGHT HYDRAULIC



H-55

■ TOGGLE CLAMPING



R 4/6

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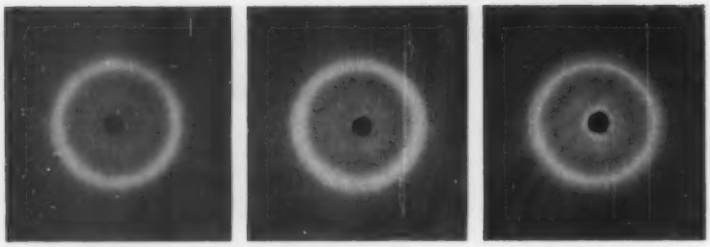
SPECIFICATIONS

AD-52

MODEL		SJ-SERIES							H-SERIES						
TYPE		SCREW & STRAIGHT HYDRAULIC							PLUNGER & STRAIGHT HYDRAULIC						
NO.		SJ-35	SJ-50	SJ-60	SJ-75	SJ-90	SJ-120	SJ-150	H-8	H-16	H-35	H-55	H-85	H-120	H-180
OZ. PER SHOT		6	16	32	72	120	360	1100	1.5/2	3/4	8/10	12/16	20/28	40/52	60/80
CLAMPING FORCE (U.S. TON)		84	195	310	480	850	1250	2500	40	84	195	310	480	850	1250
SPACE BETWEEN TIE BARS	H	10 1/4"	14 3/16"	18"	26 3/16"	39 3/8"	48 1/2"	54"	8 1/16"	10 1/4"	14 3/16"	18"	26 3/16"	39 3/8"	48 1/2"
	V	6 5/16"	11"	16"	22 1/4"	35 7/16"	40 1/2"	54"	5 5/16"	6 5/16"	11"	16"	22 1/4"	35 7/16"	40 1/2"



A B C

FIG. 7: X-ray diffraction photograms of physically treated 66/610/PIP-10 filaments. A) Sample 1563, no special treatment; B) Sample 1563 B, drawn during extrusion; C) Sample 1563 A, simultaneously drawn and quenched (0° C.) during extrusion.

1563 A: Quenched in ice water (0° C.) and drawn simultaneously.

The three filaments were first examined by means of X-ray photograms (Fig. 7, above). The intensity of the crystalline portion of the pattern was estimated from the intensity of the inner, or (110), ring of the (110) to (020) nylon doublet. This ring was most sharp for the simply extruded filament, and least sharp for the drawn and quenched filament. These data are reproduced in Table VI, below; the sharper the ring, the lower the number. The intensity of the innermost ring at 8.9 Å is also given because it appeared to show the most variation among the three filaments. This ring, the second-order reflection of the chain repeat distance, varied in intensity from faint in the "as extruded" filament to very, very faint in the drawn and quenched sample. This reduction in intensity has been interpreted to signify an orientation of chains parallel to the filament axis.

The intensity of the amorphous portion was taken from the intensity of the background between the (110) and (020) nylon doublet. On this basis, the quenched and drawn sample was the least amorphous, the "as extruded" the most amorphous. This variation in amorphous content was a reflection of the chain orientation around the filament axis in drawn samples.

Birefrigence studies on these three filaments were also made in an attempt to establish the relationship between crystallite size, treatment, and thermal stability. Unaged, all three filaments exhibited molecular orientation. As anticipated, the degree of orientation in the "as extruded" filament was low and nonuniform. The drawn filament exhibited greater birefringence; the quenched and drawn filament exhibited the highest degree of birefringence. In addition, Specimens 1563 B and A both contained some birefringent areas, needlelike in shape and oriented diagonally across the fiber. There were two sets of these acicular birefringent structures, one on each diagonal of the fiber and approximately perpendicular to one another; these structures were bright between crossed polarizers when the fiber itself was oriented at the extinction position. These crystalline areas represented only a very small percentage of the material in the filament. Qualitatively, the "as extruded" filament was the most crystalline and the drawn and quenched filament the least crystalline.

After aging for 8 **(To page 176)**

Table VI: Crystallinity of nylon 66/610/PIP-10 filaments according to X-ray diffraction

Filament	*Treatment*	*Method of examination*	*Apparent intensity of amorphous portion*	*Intensity of crystalline portion*	*Ring sharpness*	*Intensity of innermost ring, 8.9 Å*
1563 C	Extruded	Through center	Medium	Medium strong	4	Faint
1563 C	Extruded	Over side	Medium	Medium strong	3	Faint
1563 C	Extruded	Quartered	Faint	Medium	2	0
1563 B	Extruded-drawn	Through center	Medium faint	Medium strong	3	Very faint plus
1563 B	Extruded-drawn	Over side	Very faint	Medium	2	0
1563 B	Extruded-drawn	Quartered	Faint	Medium strong	3	Very, very faint
1563 A	Extruded-drawn and quenched	Through center	Faint	Medium	2	Very, very faint
1563 A	Extruded-drawn and quenched	Through center	Faint	Medium strong	2	Very, very faint

Table VII: Effect of heat aging on the tensile properties of physically treated nylon 66/610/PIP-10 filaments[a]

		Initial properties			*Properties after 8 days at 140° C.*		
Filament	*Physical treatment*	*Tensile strength*	*Yield strength*	*Elongation*	*Tensile strength*	*Yield strength*	*Elongation*
		p.s.i.	*p.s.i.*	*%*	*p.s.i.*	*p.s.i.*	*%*
1563 C	None	9,200	3,400	450	3,900	3,800	50
1563 B	Drawn during extrusion	7,200	3,300	350	4,100	0	30
1563 A	Drawn and quenched (0° C.) during extrusion	7,200	3,800	300	4,000	4,000	50

[a]Unstabilized.

Plastics production in 1960 grouped by chemical composition*

Material	Production[a] 1000 lb.	Unit value per lb.[b] dollars
Grand total	**6,283,022**	—
BENZENOID RESINS		
Total	**2,713,894**	**0.28**
Coumarone-indene and petroleum polymer resins	**264,859**	**0.11**
Epoxy resins, total	**66,211**	**0.62**
Unmodified (condensation products of phenol and derivatives with epoxy compounds)	57,952	0.62
Modified (with hardening agents and esterified with fatty acids)	8,259	0.65
Phenolic and other tar acid resins, total	**648,608**	**0.28**
Unmodified, total	**530,807**	**0.27**
Cresols-formaldehyde	7,314	0.41
Cresylic acid-formaldehyde	7,723	0.28
Phenol- (and substituted phenol)- formaldehyde	494,358	0.27
Resorcinol-formaldehyde	1,259	0.94
All other	20,153	0.41
Modified, total	**117,801**	**0.29**
Phenol- (and substituted phenols)- formaldehyde with modifiers (except rosin)	66,508	0.25
Rosin and rosin esters modified with phenolic and other tar acid resins (hard resins)	34,117	0.25
All other	17,176	0.39
Phthalic alkyd resins, total	**454.724**	**0.34**
Unmodified	345,778	0.34
Modified	118,946	0.34
Polyester resins[c]	**189,530**	**0.40**
Polyurethane and diisocyanate resins	**5,281**	**0.90**
Styrene resins, total	**1,061.737**	**0.28**
Polystyrene	686,390	0.24
Styrene-acrylonitrile copolymer	36,485	0.35
Styrene-alkyd polyesters (for protective coatings only)	29,731	0.42
Styrene-butadiene copolymer (containing 50% or more styrene), total	209,462	0.33
Latexes	134,072	0.28
Other	75,390	0.44
Styrene-divinylbenzene copolymer	22,267	0.65
All other styrene resins	77,401	0.32
All other benzenoid resins[d]	**12,944**	**0.54**
NONBENZENOID RESINS		
Total	**3,426,555**	**0.33**
Acetone-formaldehyde resins	**374**	**0.40**
Alkyd resins, except phthalic, total	**91,676**	**0.33**
Unmodified, total	**37,056**	**0.43**
Modified, total	**54,620**	**0.26**
Rosin and rosin esters, modified with maleic and fumaric acids only (hard resins)	49,171	0.26
All other	5,449	0.34
Dicyandiamide resins	**2,370**	**0.31**
Polyamide resins	**36,538**	**1.01**
Polyethylene resins, total	**1,337,160**	**0.29**
High-pressure process	1,112,683	0.28
Low-pressure process	224,477	0.33
Polypropylene resins	**40,949**	**0.41**
Rosin modifications, total	**66,354**	**0.21**
Rosin and terpene adduct resins	**3,301**	**0.23**
Rosin and rosin esters, unmodified (Ester gums), total	**56,746**	**0.21**
Esterified with glycerol	24,702	0.22
Esterified with other alcohols (methanol, glycols, pentaerythritol, etc.)	32,044	0.20
All other	6,307	0.25
Silicone resins	**5,125**	**2.83**
Urea and melamine resins, total	**398,989**	**0.29**
Urea-formaldehyde type	268,185	0.22
Melamine-formaldehyde type	130,804	0.45
Vinyl and vinyl copolymer resins, total[e]	**1,202,970**	**0.29**
Polyvinyl acetate	156,298	0.35
Polyvinyl alcohol	34,725	0.62
Polyvinyl chloride and copolymer resins (containing 50% or more polyvinyl chloride)	935,508	0.23
All other vinyl resins[f]	76,439	0.82
All other nonbenzenoid resins[g]	**244,050**	**0.68**
CELLULOSE PLASTICS		
Total	**142,573**	—
Cellulose acetate and mixed esters, total	**141,425**	—
Sheets, continuous, under 0.003 in. gage	18,562	—
Sheets, continuous, 0.003 in. gage and over	22,346	—
All other sheets, rods, and tubes (including other cellulose plastics)	9,300	—
Molding and extrusion materials (including other cellulose plastics)	91,217	—
Nitrocellulose sheets, rods, and tubes	**1,148**	—

* Source: U. S. Tariff Commission.

[a] For the purpose of this report, "dry basis" is defined as the total weight of the material, **including** resin, plasticizers, fillers, extenders, colors, and stabilizers, and **excluding** water, solvents, and other liquid diluents.

[b] Calculated on rounded figures.

[c] Polyester resins, for the purpose of this report, include unsaturated alkyds copolymerized with monomers such as styrene, and polyallyl resins such as diallyl phthalate, and allyl diglycol carbonate. Styrene-alkyd polyester for protective coatings are included under **Styrene resins.**

[d] Includes data for aniline-formaldehyde, toluenesulfonamide, and other benzenoid resin materials not specifically classified.

[e] Based on resin content only.

[f] Includes data for polyvinyl butyral and formal, and for copolymers containing less than 50% polyvinyl chloride.

[g] Includes data for acrylic and other nonbenzenoid resin materials.

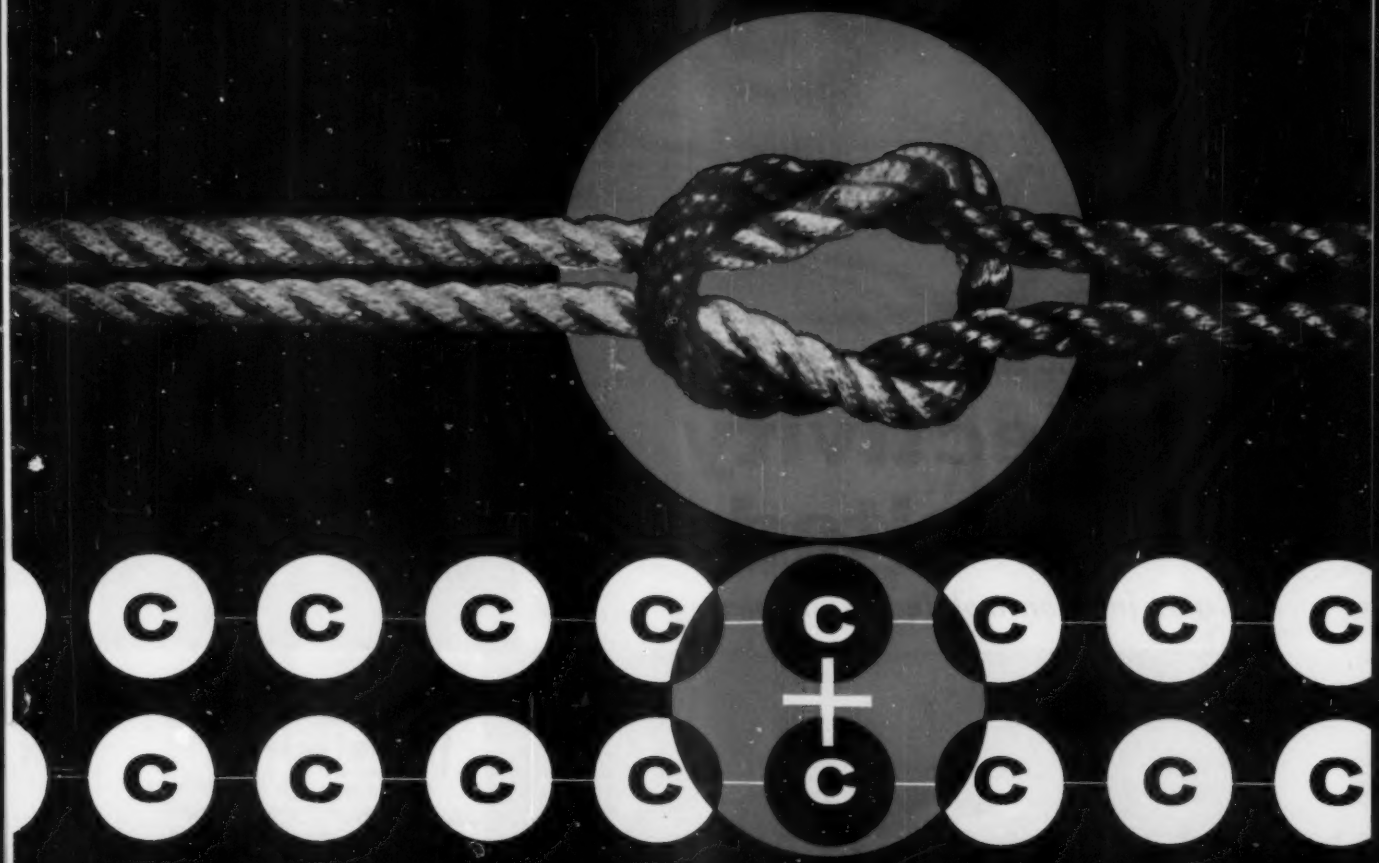
(More statistics appear on p. 124)

Plastics production in 1959 and 1960 grouped by classes and uses[a]

Material	1959 1000 lb.	1960 1000 lb.
Grand total	**6,021,318**	**6,283,022**
Cellulose plastics, total	**158,088**	**142,573**
Cellulose acetate and mixed esters:		
Sheets, continuous, under 0.003 in. gage	19,482	18,562
Sheets, continuous, 0.003 in. gage and over	22,581	22,346
All other sheets, rods, and tubes (including other cellulose plastics)	9,052	9,300
Molding and extrusion materials (including other cellulose plastics)	103,993	91,217
Nitrocellulose sheets, rods, and tubes	**2,980**	**1,148**
Phenolic and other tar-acid resins, total	**624,793**	**648,608**
Molding materials	229,022	207,195
Bonding and adhesive resins for—		
Laminating	75,597	71,703
Coated and bonded abrasives	16,208	14,653
Friction materials	16,872	22,069
Thermal insulation	51,716	84,145
Plywood	61,455	70,529
All other bonding and adhesive uses	63,415	68,555
Protective coatings:		
Unmodified	25,251	23,576
Modified, except by rosin	4,786	3,231
Rosin esters modified by phenolic and other tar-acid resins (hard resins)	29,112	32,533
Resins for all other uses	51,359	50,419
Urea and melamine resins, total	**423,602**	**398,989**
Textile-treating and textile-coating resins	46,094	44,827
Paper-treating and paper-coating resins	30,381	32,019
Bonding and adhesive resins for—		
Laminating	36,382	35,425
Plywood	106,468	92,334
All other bonding and adhesive uses	27,663	30,979
Protective coating resins, straight and modified	38,566	41,244
Resins for all other uses, including molding	138,048	122,161
Styrene resins, total	**976,937**	**1,061,737**
Molding materials, total	**667,789**	**731,378**
Straight polystyrene	319,200	351,987
All other	348,589	379,391
Protective coating resins, straight and modified[b]	81,642	76,045
Textile- and paper-treating and coating resins	63,155	70,434
Resins for all other uses	164,351	183,880
Polyurethane and diisocyanate resins	**4,720**	**5,281**
Vinyl and vinyl copolymer resins[c], total[d]	**1,166,465**	**1,202,970**
Polyvinyl chloride and copolymer resins (containing 50% or more polyvinyl chloride) for:		
Film (under 0.010 in. gage)	88,904	99,954
Sheeting (0.010 in. gage and over)	130,178	131,137
Molding and extrusion	305,947	300,154
Textile and paper treating and coating	68,449	64,572
Flooring	153,007	156,169
Protective coatings	31,367	38,586
All other uses	96,506	112,696
All other vinyl resins for:		
Adhesives	59,495	70,364
Protective coatings	25,275	28,866
All other uses	142,470	127,346
Alkyd resins, total	**559,941**	**556,400**
For protective coatings:		
Phthalic anhydride types:		
Unmodified	348,101	352,207
Modified	120,630	108,694
Polybasic acid types:		
Unmodified	15,224	13,251
Modified (except by rosin)	10,933	9,275
Rosin esters modified with maleic and fumaric acids only (hard resins)	40,099	37,852
For all other uses	24,954	35,121
Rosin esters, total	**73,523**	**71,295**
Unmodified (ester gums) for protective coatings	25,653	21,660
All other modifications for protective coatings and other uses	47,870	49,635
Coumarone-indene and petroleum polymer resins	**318,330**	**264,859**
Polyester resins, total	**180,672**	**189,530**
For reinforced plastics	129,472	152,946
For all other uses	51,200	36,584
Polyethylene resins, total[d]	**1,194,987**	**1,337,160**
For film and sheeting	344,353	386,837
Molding materials	216,479	165,807
Extrusion materials	155,049	155,991
For all other uses	400,367	486,383
Polypropylene	**—**	**40,949**
Silicone resins	**5,027**	**5,125**
Epoxy resins, total[d]	**56,821**	**66,211**
For protective coatings	20,672	17,672
For all other uses	24,561	48,539
Miscellaneous plastics and resin materials[c]	**277,412**	**288,484**

[a] Source: U. S. Tariff Commission. "Dry basis," for the purpose of this report, is defined as the total weight of the material, **including** that of resin, plasticizers, fillers, extenders, colors, and stabilizers, and **excluding** that of water, solvents, and other liquid diluents.
[b] Includes data for styrene-alkyd polyester resins.
[c] Based on resin.
[d] Total is based on production; statistics by use are based on sales.
[e] Includes data for acrylic, toluenesulfonamide, and other plastics and resin materials.

(More statistics appear on p. 127)



DI-CUP® . . . *The Chemical Way to Cross-Link Polyethylene*

Di-cup, Hercules dicumyl peroxide, is a source of free radicals, which are highly effective in chemical cross-linking. It provides a simple, economical, and practical means of cross-linking low-density polyethylene.

Cross-linked polyethylene is a thermoset material resistant to softening and deformation at high temperatures. It shows no evidence of environmental stress cracking and it is resistant to many solvents at high temperatures.

This development opens new markets for products that require superior toughness, flexibility, impact strength, and chemical resistance.

For more information on Di-cup, write

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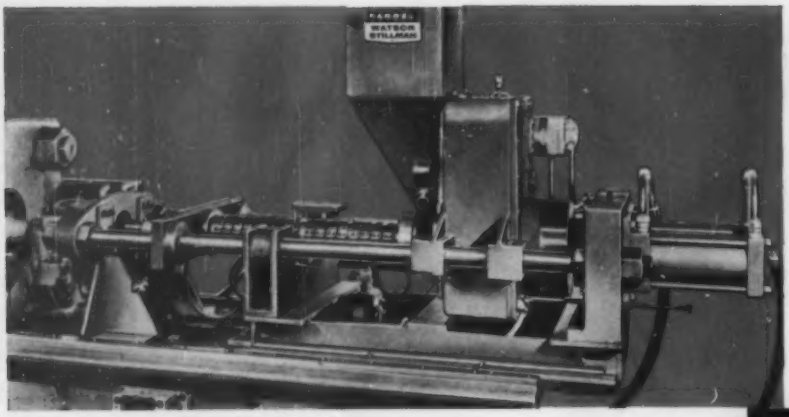


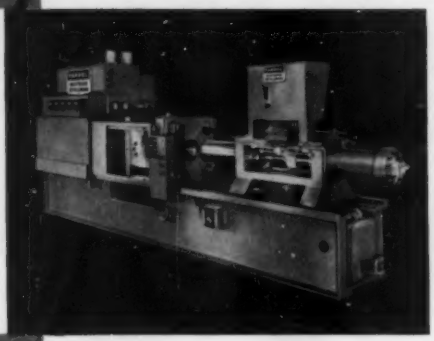
screw-type plasticizer

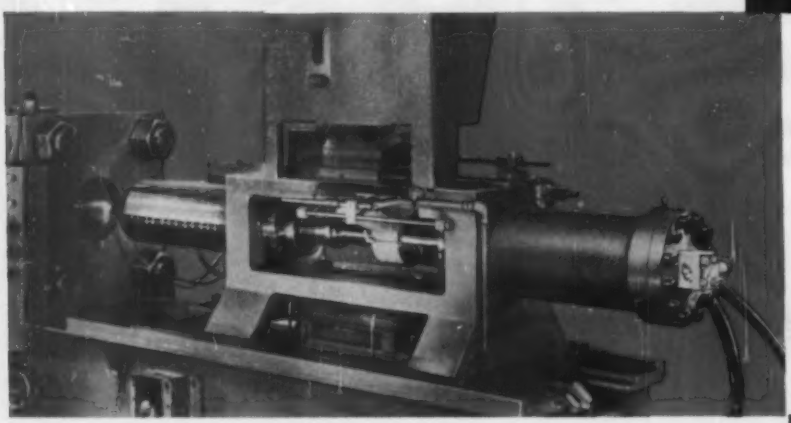
Here is a new machine designed for high product uniformity and strength and excellent color dispersion. Ideal for running heat-sensitive materials because they are worked mechanically. Can be supplied with three different screws for molding different materials.

These two new machines mean

selectivity unlimited

on your injection molding requirements





plunger-type plasticizer

All-new machine for molders requiring a normal straight-shooting machine of advanced design. Delivers high output with low cost and minimum maintenance. Will mold a great variety of products with excellent dimensional stability and fine surface finish.

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STILLMAN
®

Suggestive of the unusual degree of selectivity available to you at Farrel Watson-Stillman are the two new 12 to 20 ounce machines illustrated. Each has advantages depending on the needs of the individual molder. The screw-type version, for example, assures high quality in molding the more difficult types of plastic materials . . . can be ordered with a choice of 41 optional features! The plunger-type machine has appeal for those interested in a normal straight-shooting machine.

Send for details and specifications of these versatile machines. Ask for a copy of bulletin 601.

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WS-84

Plasticizers production in 1959 and 1960[a]

Plasticizer	1959 1000 lb.	1960 1000 lb.	1960 unit value[b] $/lb.
Grand total	**538,834**	**602,135**	**0.30**
Cyclic plasticizers, total	**403,114**	**444,744**	**0.27**
Phosphoric acid esters:			
Cresyl diphenyl phosphate[c]	10,525	12,874	0.28
Tricresyl phosphate[c]	31,375	32,485	0.30
Triphenyl phosphate	8,427	9,466	—
Phthalic anhydride esters, total	**306,415**	**344,741**	**0.26**
Butyl decyl phthalate	—	4,752	0.24
Butyl octyl phthalate	—	13,190	0.25
Dibutyl phthalate	15,130	18,946	0.27
Dicyclohexyl phthalate	6,683	5,777	—
Didecanoyl phthalate (dicapryl phthalate)	—	4,364	0.26
Diethyl phthalate	16,128	16,767	0.24
Diisodecyl phthalate	28,777	35,538	0.26
Di(2-methoxyethyl) phthalate	2,991	3,855	0.36
Dimethyl phthalate	3,318	3,386	0.25
Dioctyl phthalates, total	152,702	170,220	0.25
Di(2-ethylhexyl) phthalate	106,575	123,396	0.25
Diiso-octyl and mixed octyl phthalates	46,127	46,824	0.25
Ditridecyl phthalate	—	582	0.33
Octyl decyl phthalates, total	**20,466**	**16,343**	**0.26**
Iso-octyl isodecyl phthalate	4,722	6,276	0.24
n-Octyl *n*-decyl phthalate	10,291	10,067	0.28
All other	5,453	—	0.25[f]
All other phthalic anhydride esters	60,220	51,021	0.28
All other cyclic plasticizers[d]	**46,372**	**45,178**	**0.33**
Acyclic plasticizers, total	**135,720**	**157,391**	**0.39**
Adipic acid esters, total	**14,035**	**22,136**	**0.40**
Di(2-ethylhexyl) adipate	1,850	3,040	0.39
Diisobutyl adipate	—	—	0.41
Diisodecyl adipate	2,989	3,167	0.40
Diiso-octyl adipate	3,561	4,233	0.39
Octyl decyl adipate	1,770	4,983	0.39
Complex adipic acid polyesters	3,068	4,794	0.44
All other	797	1,919	0.44
Azelaic acid esters, total	**8,078**	**7,295**	**0.46**
Di(2-ethylhexyl) azelate	7,091	6,304	0.46
All other	987	991	—
Dibutyl maleate	**—**	**5,519**	**—**
Glyceryl monoricinoleate	**430**	**298**	**0.36**
Oleic acid esters, total	**7,309**	**6,219**	**0.28**
Butyl oleate	2,101	1,822	0.22
Methyl oleate	948	664	—
All other	4,260	3,733	0.29
Palmitic acid esters	**2,904**	**—**	**0.26[f]**
Phosphoric acid esters	**8,231**	**9,481**	**0.41**
Sebacic acid esters, total	**9,969**	**13,781**	**0.60**
Dibutyl sebacate	3,993	3,596	0.63
Di(2-ethylhexyl) sebacate	—	9,178	0.59
All other	5,976	1,007	0.59
Stearic acid esters, total	**14,792**	**12,288**	**0.28**
n-Butyl stearate	4,118	3,501	0.24
All other	10,674	8,787	0.30
Triethylene glycol di(caprylate-caprate)	**2,688**	**2,009**	**0.38**
All other acyclic plasticizers[e]	**67,284**	**78,365**	**0.37**

[a] Source: U. S. Tariff Commission.
[b] Calculated on rounded figures.
[c] Includes material produced for use as motor fuel additive.
[d] Includes data for toluenesulfonamides, tetrahydrofurfuryl oleate, and other cyclic plasticizers.
[e] Includes data for citric and acetylcitric, tartaric and ricinoleic acid esters, and for butyl myristate, glyceryl and glycol esters of certain fatty acids, glyceryl tripropionate, complex polymeric materials and other acyclic plasticizers.
[f] 1959 unit value.

(More statistics appear on p. 128)

Synthetic elastomers production in 1959 and 1960[a]

Product	1958 production	1959 production	1960 production	1960 unit value
	1000 lb.	1000 lb.	1000 lb.	per lb[b]
Synthetic elastomers, total	**2,201,950**	**2,825,339**	**2,952,390**	**$0.27**
Polybutadiene-styrene type (S-type)	1,752,541[d]	2,210,380	2,262,646	0.24
Polybutadiene-styrene-vinyl pyridine type	—	—	13,746	0.65
Polyurethane type	—	2,377	6,798	0.94
Polybutadiene-acrylonitrile type (N-type)	71,626	96,699	84,894	0.48
Polychloroprene type (Neoprene)	219,085	279,586	301,150	—
Polyisobutylene-isoprene type (Butyl)	117,033	181,458	219,408	—
Silicone elastomers	—	5,215	4,940	4.01
All other elastomers[c]	41,665[e]	49,624	58,808	0.34

[a] Source: U. S. Tariff Commission. The term "**Elastomers**" is defined as substances in bale, crumb, powder, latex, and other crude forms, which can be vulcanized or similarly processed into materials which can be stretched at 68° F. to at least twice their original lengths and which after having been so stretched and the stress removed, return with force to approximately their original lengths. [b] Calculated on rounded figures. [c] Includes data for polyalkylene sulfide, polybutadiene, and polyisobutylene elastomers, and for natural rubber modifications. [d] Included small amount of polyurethane type. [e] Included small amount of silicone elastomers.

Synthetic resin imports in 1960[a]

Product	Quantity	Product	Quantity
	lb.		lb.
Synthetic resins, total	**2,509,187**	Polyester resins	469,890
"Akemi" stone and marble cement	13,324	Polystyrene resins	458,248
Phenolic resins	75,333	Polyurethane resins	439,288
Plastic phosphors	53	Vinyl resins	147,467
Polyamide (nylon) resins	718,970	Miscellaneous plastics and resins	186,614

[a] Source: U. S. Tariff Commission.

This NEW 3" x 8" THROPP MILL *expedites* rubber and plastics research

Aided by many years of experience in designing laboratory mills, Thropp engineers have developed this up-to-date 3" x 8" model. It sets new standards for attractive modern design, compactness and economical maintenance.

The new mill, designed for processing small batches, is one of the Thropp family of rubber and plastics mills, ranging in size up to 84". The machine has tilting type guides to facilitate thorough and rapid cleaning and prevent carry-over of color or other contamination to subsequent batches.

Manufacturers who appreciate the importance of fast, accurate, economical research and development work will find this machine a sound investment. Send for further information.

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LOOK----------

it's all one piece!

Opening and closing this one-piece carrying case demonstrates the remarkable "hinge" property of TENITE POLYPROPYLENE

Flexed a million times in one continuous laboratory test, a molded specimen of Tenite Polypropylene—the Eastman plastic with the "built-in hinge"—showed never a crack. That's why this case can have its base, cover, and handle molded as a unit, with obvious savings in design, fabrication, and assembly.

Made for a child's typewriter, the case is well able to take slam-bang treatment that will come its way. The high abrasion resistance demonstrated in this use gives long life to the beauty of many products made from Tenite Polypropylene, and also suggests its use for gears, bearings, and similar hard-working parts.

In addition to being injection molded, Tenite Polypropylene can be extruded into film, sheeting, and monofilaments, and in special formulations is adaptable to blow molding, where its exceptional strength permits thin walls. The film is sparkling clear, heat-sealable, printable, and an effective moisture barrier—important features in packaging. Rigid sheet is readily thermoformed on standard equipment into large-scale sections or skin packaging.

As extruded wire covering, Tenite Polypropylene exhibits excellent electrical and thermal properties. And formulations combining weatherability, low-temperature flexibility, and high tensile strength may be used to produce monofilaments that are ideal for such applications as webbing for outdoor furniture.

With the lightest weight of any solid plastic, Tenite Polypropylene gives the greatest product yield per pound. As for colors, thousands of vibrant hues are available in Tenite Polypropylene—or in color concentrates for mixing with uncolored plastic to produce the desired color when molded or extruded. Eastman experience in coloring plastics extends over 25 years, with additional background in color photography and textile dyes. In applying this plastic to your product ideas, you can call on the aid of Eastman's technical representatives and its extensive laboratory facilities. For information on Tenite Polypropylene or any other plastics in the Tenite family—butyrate, acetate, propionate, or polyethylene—write EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENNESSEE.

Carrying case molded by manufacturer of the "Tom Thumb" typewriter, Western Stamping Company, Jackson, Michigan.

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POLYPROPYLENE

an Eastman plastic

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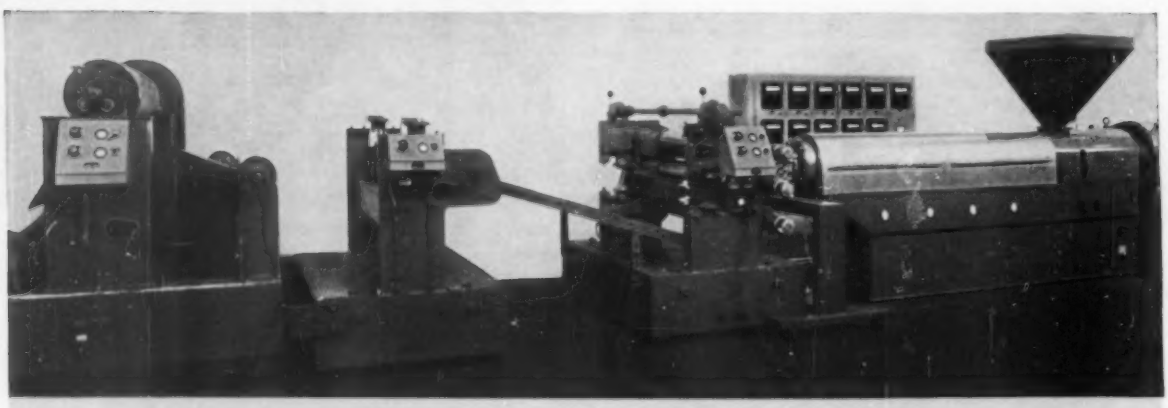
THE MARK OF QUALITY

IN EXTRUSION INSTALLATIONS AND ACCESSORIES

Whether you are in the market for an extruder, a complete extrusion installation, or accessory equipment, Frank W. Egan & Company will meet your requirements.

Egan offers a complete line of extruders—direct electric heat, air cooled, or the highly advanced "Willert Temperature Control" model. All units are equipped with heavy duty thrust bearings, herringbone gear speed reducers, and many other superior operating and maintenance features to assure years of trouble-free operation at high output rates.

Egan Extruders are available in sizes from 2″ through 12″, vented or non-vented, with L/D ratios of 20:1, 24:1, 32:1.



Shown above is a 48″ Sheet Extrusion Installation with a 4½″ Egan Extruder incorporating the improved Air Cooled Willert Temperature Control System. Manifold type dies up to 80″ wide with an adjustable restrictor bar are available, as well as three-roll finishing units, automatic shears, automatic stackers, and winders.

The Sheeting Line will handle the following materials: Hi-impact Styrene, ABS Polymers, Polyethylene, Acetate, and Butyrate.

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NEW DEVELOPMENTS

Many kinds of work on new ways to use plastics, new designs, and new product concepts offer ideas you can use.

NEW REFRIGERATED FREIGHT CARS feature interior wall linings of ABS-styrene foam sandwich panels. Use of new liners offers greater insulating efficiency, provides an extra 450 cu. ft. of cargo space over conventional plywood liners with cork cores.

SANDWICH PANELS are stacked prior to installation along interior of reefer cars. Vacuum formed ABS shell forms top surface of panel, core of sandwich is polystyrene foam, and undersurface of panel is backed with plywood.

Now . . . ABS-foam liners for reefer walls

A vacuum-formed acrylonitrile-butadiene-styrene (ABS) shell with a polystyrene foam insulating core is the basic unit in a new method of lining the interior walls of refrigerated freight cars. In this outstanding plastics application, 890 sq. ft. of ABS sheet, representing from 900 to 925 lb., are incorporated in each car!

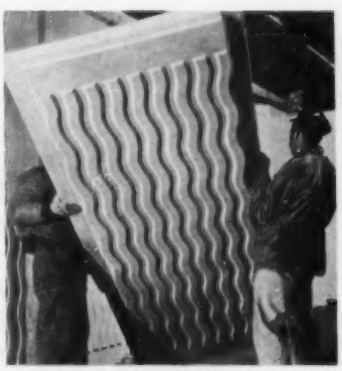
The use of ABS-foam panels as car wall liners is a logical outgrowth of the successful application of similar panels as reefer car door liners. (See "Burgeoning bead board business," MPI, July 1960, p. 97, and "Giant thermoformed parts," MPI, Sept. 1960, p. 91). The insulated doors, which are more than 2 ft. wider yet about 500 lb. lighter than conventional doors, are featured with the new wall liners in a line of cars recently introduced by Pacific Fruit Express.

The wall liners offer high resistance to shock and impact at sub-zero temperatures, excellent moisture resistance, durability, and good strength. Overall cargo capacity in the freight cars has been increased by approximately 450 cu. ft., because the 6½-in.-thick lining is considerably thinner than linings formerly made from plywood-cork-plywood panels. And insulating performance has reportedly been upgraded—cars lined with the ABS-foam panels can maintain any temperature from —10 to 70° F., permitting perishable foods to be loaded at the most desirable temperature and kept at that level.

The reefer liners are fabricated by Landis Industrial Co. Inc., Santa Clara, Calif., which also produces the insulated reefer doors. The ABS shell is vacuum formed with a modified S-curve corrugation in its surface. This configuration allows movement of cold air around closely-packed cargo, yet is designed and spaced so that corners of containers cannot catch or hang up on the corrugations. Cold air moves down through a duct in the top of the car, flows along the corrugated panels, and is pulled back toward the blower end of the car.

The formed ABS shells act as pans to hold the pre-expanded polystyrene foam beads during final expansion by means of steam probes in a foam-molding machine. After foaming is completed, a plywood backing is cemented to the top surface of the foam.

Bolting of the finished sandwich panels to the sheet walls of the reefer car is done through a 4-in. offset lip produced along the vertical edges of each panel. The space remaining between panels is filled in, first by a 1-in.-thick wood block, carefully caulked to prevent loss of insulating efficiency, then by a 2-in.-thick cap panel, also vacuum formed of ABS, which is cemented to the wood block. The outer surface of the ABS cap panel retains the corrugated pattern of the larger panels. Because the panels are not fastened together, they have a degree of independent movement and can adapt to thermal expansion and contraction.



PANELS are lifted into place for installation, will be bolted to car walls through offset lip produced along both vertical edges of the panel.

ABS sheet is extruded and supplied by Jet Specialties Co. Inc., Los Angeles, Calif., which uses Cycolac H resin from Marbon Chemical Div., Borg-Warner Corp., Washington, W. Va. Dylite expandable polystyrene beads are supplied by Koppers Co. Inc., Pittsburgh, Pa.

(More on p. 134)

OPALO

A NEW PLASTISOL GENERAL PURPOSE RESIN THAT COMBINES MORE HIGH-

Tests show that Opalon 440 vinyl paste resin combines these high-performance properties:

HEAT STABILITY. In a wide variety of commercially used stabilizer systems, Opalon 440 has better heat stability than all other paste resins. Resists discoloration, decomposition, degradation and loss of clarity.

CLARITY. Plastisols made with 440 develop greater clarity than those of any other paste resin. There is less haze at low fusion temperatures, and almost perfect clarity at ultimate fusion temperatures. This is indicative of high PVC content and excellent compatability with plastisol ingredients.

LOW MOISTURE SENSITIVITY. 440's low moisture content stays constant even under high humidity conditions, helps prevent blistering at the time of fusion.

Opalon 440 is also characterized by excellent light stability; low mold plate-out; easier color matching with less color drift; improved gelation properties; low viscosity with little variation. In addition, more rapid dispersibility and thorough wetting help cut mixing time.

For test results and data sheet, send coupon below to Monsanto Chemical Company, Plastics Division, Room 826, Springfield 2, Mass.

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Beverage case-picnic cooler

A six-pack for canned soft drinks that doubles as a picnic cooler is now being molded of expandable polystyrene beads. First use of this product is in Canada, where it retails for just below $1.00, including the six drinks and a braided polypropylene rope handle. The empty cooler weighs about 3 oz. and sells for about 33 cents. The package is so designed that the cans nest in six molded-in recesses along the inside periphery of the two-part container. This arrangement leaves a well at the center for ice.

The cooler is molded in cast aluminum molds, using a core box to admit steam into the die cavity. Using a fusion pressure of 15 p.s.i., cycle was 3 min. at a foam density of 1.5 to 2 lb. per cu. foot. Top and bottom sections are identical, keeping mold costs down.

Pelaspan-60 expandable polystyrene resin is supplied by Dow Chemical Co. of Canada. Produced by Cellair Canada, Ajax, Ont., for Structural Foams of Canada, Toronto, Ont. Design and materials selection for the novel picnic cooler by McCann Assocs., Toronto.

Phenolic control for washer

Three phenolic baffles, each equipped with electronic sensory elements, are the "brains" that control the shut-off switch and timing mechanism of an automatic laundry dryer recently introduced by The Maytag Co., Newton, Iowa.

As the dryer drum rotates, the electronic elements (thin bands visible in photographic closeup) on the baffles constantly touch or "feel" the clothes. When the moisture content falls to a predetermined level, these elements automatically shut off the dryer or activate the timing device. The timer can control the final conditioning and cool-down of regular and extended dryer settings.

Cotton flock-filled phenolic material, selected for its combination of bonding strength, low moisture pickup, and high impact strength, is used in the compression molding of the baffles. The electronic elements consist of wire coiled around each baffle in 24 molded-in grooves, the ends passing to control mechanisms through holes in the drum. Baffles are attached to the drum with self-threading screws. Molder of the baffles is Chicago Molded Products Corp., which uses compounds supplied by Union Carbide and Durez Plastics Div. of Hooker Chemical.

Convenience, safety, cleanliness—all three from PE

Sirup dispenser

Reusable polyethylene closure-dispenser for chocolate sirup, juice, oils, etc., incorporates a molded-in spout that prevents contents from dripping down the side of cans. A PE cap covers the spout when not in use. The lid consists of two parts: body and liner. The liner, which snaps into the body, has two holes molded in to allow the free circulation of air. This avoids creation of vacuum in the can and assures free, non-surge flow of contents. The all-plastics unit can be easily taken apart for cleaning purposes.

The dispensers are molded of Du Pont Alathon 37 resin by Crystal Thermoplastics, Pawtucket, R. I., for Siax Industries Inc., Newton Highlands, Mass.

Radiator overcap

Molded polyethylene cover that fits over automobile radiator caps protects service station attendants from being burned or scalded when removing the cap for service. The cover fits radiator caps of most American cars, and is readily removed. Because the cap has a diameter about one-and-a-half times that of the metal cap underneath, it tends to deflect steam and hot water in the case of overheating.

The cap comes in red, blue, green, white, and yellow; and can be personalized by hot stamping or molding. Manufacturer is McCamey & Co., Orange, Texas, using Du Pont Alathon resin. Caps are distributed to service stations by jobbers at 30¢ each.

Folding shovel

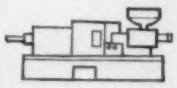
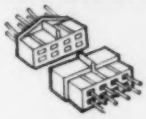
Injection molded of high-density polyethylene, 41-in.-tall shovel is designed to fold to a convenient 21½-in. size when not in use. This feature makes it particularly suitable for carrying in the trunk of a car ready for snow emergency use. However, it has also found application in the home for gardening, spreading fertilizer, and general utility work.

High-density material was selected because of its rigidity and light weight. Each shovel weighs only 1 lb., 10 oz., a fraction of the weight of steel units.

Molder is Beacon Plastics Corp., Newton, Mass. Marlex PE is supplied by Phillips Chemical Co.

(More on p. 136)

What's News In Plastics...

Escon® polypropylene offers molders  a balanced combination of properties for a wide range of molding applications such as high strength and impact resistance in automobile dash boards ...excellent electrical properties for cable connectors  ...high heat distortion temperature in vaporizers ...low water pick-up in distributor caps ... outstanding dynamic fatigue resistance for "living hinge" in accelerator pedals and snap-fit closures for containers...outstanding chemical resistance plus high gloss, surface hardness, and quality "feel" in dinnerware . All available for volume production at low cost.

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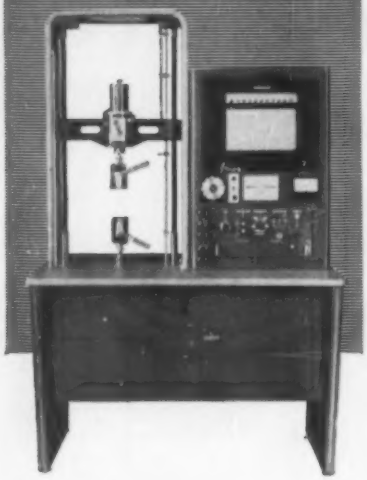

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Acrylic-enclosed street bridge

An 86-ft. bridge that spans a street high above traffic in Denver, Colo., is completely enclosed by transparent acrylic panels to provide a sundeck atmosphere for strollers.

A material selection problem was presented by the curved design of the bridge enclosure. Glass was considered impractical because of forming difficulties and the possibility of breakage. But acrylic sheets could be readily formed into the curved sections required and could also withstand severe blows without breaking. In addition, acrylic panels offered a highly weather-resistant covering.

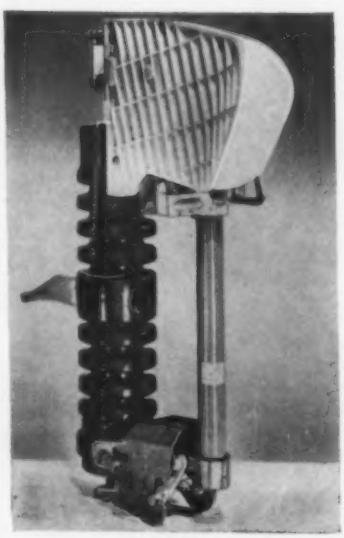
The bridge enclosure forms a semi-circular arch with a 10-ft., 1-in. radius. Framework for the covering consists of two steel girders spanning the street and 37 semi-circular steel ribs set at 28¼-in. intervals. Four acrylic sheets measuring 28 in. wide are joined end-to-end to enclose fully the spaces between each pair of steel ribs. A total of more than 2500 sq. ft. of acrylic sheeting was used for the enclosure. Fabrication of the sheet (Rohm & Haas' Plexiglas) into the curved sections was done by Regal Plastics, Englewood, Colo.

Vertical seams of the panels are sealed with cork-Neoprene gaskets, and solvent-cemented V-joints were used to produce a strong nearly invisible seam where the ends of the acrylic sections abut. The bridge was designed by the New York firm of I. M. Pei & Associates.

Acetal arc chute permits easy servicing

A molded acetal arc chute plays a key role in a new method of interrupting high load currents on outdoor power poles to permit easy servicing and repair.

By means of this new load-breaking method, developed by Westinghouse Electric Corp., power can be repeatedly interrupted by lowering a contact blade down between the facing grids of the two-piece arc chute, away from the contact points. A normal arc is given off during this operation, but it is extinguished in less than 0.1 sec. by a de-ionizing gas generated inside the arc chute by the resulting arc heat.



The lineman uses a standard hooked handpole to pull downward on an eye attached to the fuseholder. This unlatches the main contact and lowers the contact blade. To restore service, the lineman simply pushes the blade up through the chute into its original contact points. The need for replacing parts such as fuse links and gas bottles, after interruption of a power load, is eliminated.

Acetal's structural strength, non-tracking and non-carbonizing characteristics, erosion and abrasion resistance, weatherability, low-temperature toughness, good electrical and insulating properties, and non-adherent surface, were factors leading to its selection for the arc chute. Extensive testing, including up to 200 load break operations on one unit (normal lifetime may be only 5 to 10 operations), indicated no failures, no carbon tracking, almost no wear, and only slight discoloration.

The acetal arc chute, weighing about 1 lb., is injection molded by Chicago Molded Products Corp., Chicago, Ill., which uses Delrin (Du Pont) acetal resin.—**End**

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LITERATURE

Write for these publications to the companies listed. Unless otherwise specified, they will be sent gratis to executives who request them on business stationery.

"Polyolefin Resin Processes," *by Marshall Sittig.*

Published in 1961 by the Gulf Publishing Co., Book Div., 3301 Buffalo Dr., Houston 1, Texas. 242 pages. Price: $6.50.

Based largely on a study of the patent literature existing on the polymerization of ethylene, propylene, and related polyolefin products, this book is primarily designed to aid the chemical or process engineer involved in the conversion of monomers to polymers. After an opening chapter on the growth of the industry, the book discusses preparation of raw materials, catalysts, operating techniques and equipment, and the differences between the many patented processes for producing olefinic polymers. It winds up with a discussion of polymer properties and presents a list of patents and a bibliography on olefinic polymerization processes. Tersely written, it is an excellent roundup of process technology which is available.—*G.R.S.*

"Vinylidene chloride-acrylic acid ester mixed polymerizates," *by Otto Schwab.*

Published by Westdeutscher Verlag/ Colorne und Opladen W. Germany in 1961. 28 p. Price DM 9.30 (about $3.00). In German.

This is a research report covering an investigation of polyvinylidene chloride-acrylic acid esters in paper coating, with special reference to how dispersions and solutions of this material form films and the transition from the liquid to the crystalline state. The report sheds considerable light on the process of film formation from aqueous dispersions.

Self-crosslinking agent. "Self-Crosslinking Copolymer Latex for Paper Saturation" describes the general properties of X-Link 2833, and points out its use for cellulosic and synthetic paper saturation. The brochure also gives performance data, formulation, variety of applications, etc. 17 pages. *National Starch & Chemical Corp., 750 Third Ave., New York 17, N. Y.*

TFE fluorocarbons. Characteristics and qualities of Rulon and Teflon shapes and fabricated parts, including comparison of electrical, physical, mechanical, and chemical properties of these TFE fluorocarbon resins. 4 pages. *Dixon Corp., Bristol, R. I.*

Reinforcing media. "Micro-Quartz and Micro-Fibers Fibrous Insulation and Reinforcing Materials for the Aviation and Missile Industries" contains illustrations and tabular data, physical properties, thermal conductivity, available sizes and densities, etc., for these materials. Micro-Quartz is used for reinforcing high-temperature plastics. Bulletin IN-330A. 4 pages. *Johns-Manville, 22 E. 40th St., New York 16, N. Y.*

High-density polyolefin sheet. "Extrusion of Sheet from High-Density Polyolefins" shows how Marlex high-density PE and ethylene copolymers are being extruded into sheet using the commercially-available equipment developed initially for high-impact styrene. Includes discussion on resins and equipment, start-up procedure, operating guide, typical sheet properties, typical extrusion conditions, etc. 10 pages. *Phillips Chemical Co., Bartlesville, Okla.*

Polystyrene; polyethylene. Properties, advantages, uses, etc., for Lupolen 1852 E Black 413 PE; Lupolen 6001 D PE; and Polystyrol 475 impact-resistant polystyrene. 4, 4, and 6 pages, respectively. In German. *Badische Anilin- & Soda-Fabrik AG, Ludwigshafen am Rhein, West Germany, and BASF Inc., 375 Park Ave., New York 22, N. Y.*

Compression molding presses. Specifications, features, and advantages for a line of 25-, 50-, and 60-ton plastics compression molding presses. Also includes data on the Thredmolder, an attachment designed to make threaded plastic parts, and the Automite press, designed primarily for short production runs. Bulletin 435. 8 pages. *Dake Corp., 644 Robbins Rd., Grand Haven, Mich.*

White mineral oil. "White Mineral Oil for Use in the Plastics Industry" outlines applications of these oils and fully refined hydrocarbon distillates in the manufacture of various plastics. 9 pages. *Sonneborn Chemical & Refining Corp., 300 Park Ave. S., New York 10, N. Y.*

Polyethylene. "Weatherable Tenite Polyethylene for Agricultural Uses" describes this company's new weathering inhibitor, UVI-No. 5, which is said to make possible an unpigmented polyethylene film suitable for agricultural use for more than one growing season. Technical Report 5. 8 pages. *Eastman Chemical Products Inc., Kingsport, Tenn.*

Plastics for military and industrial uses. Brochure covers the firm's line of laminated plastics, printed circuit boards, flexible insulation, molded plastics, vulcanized fibre and mica products, and lists products and capabilities for advanced military and industrial applications. Catalog A-61. 16 pages. *Continental-Diamond Fibre Corp., Newark, Del.*

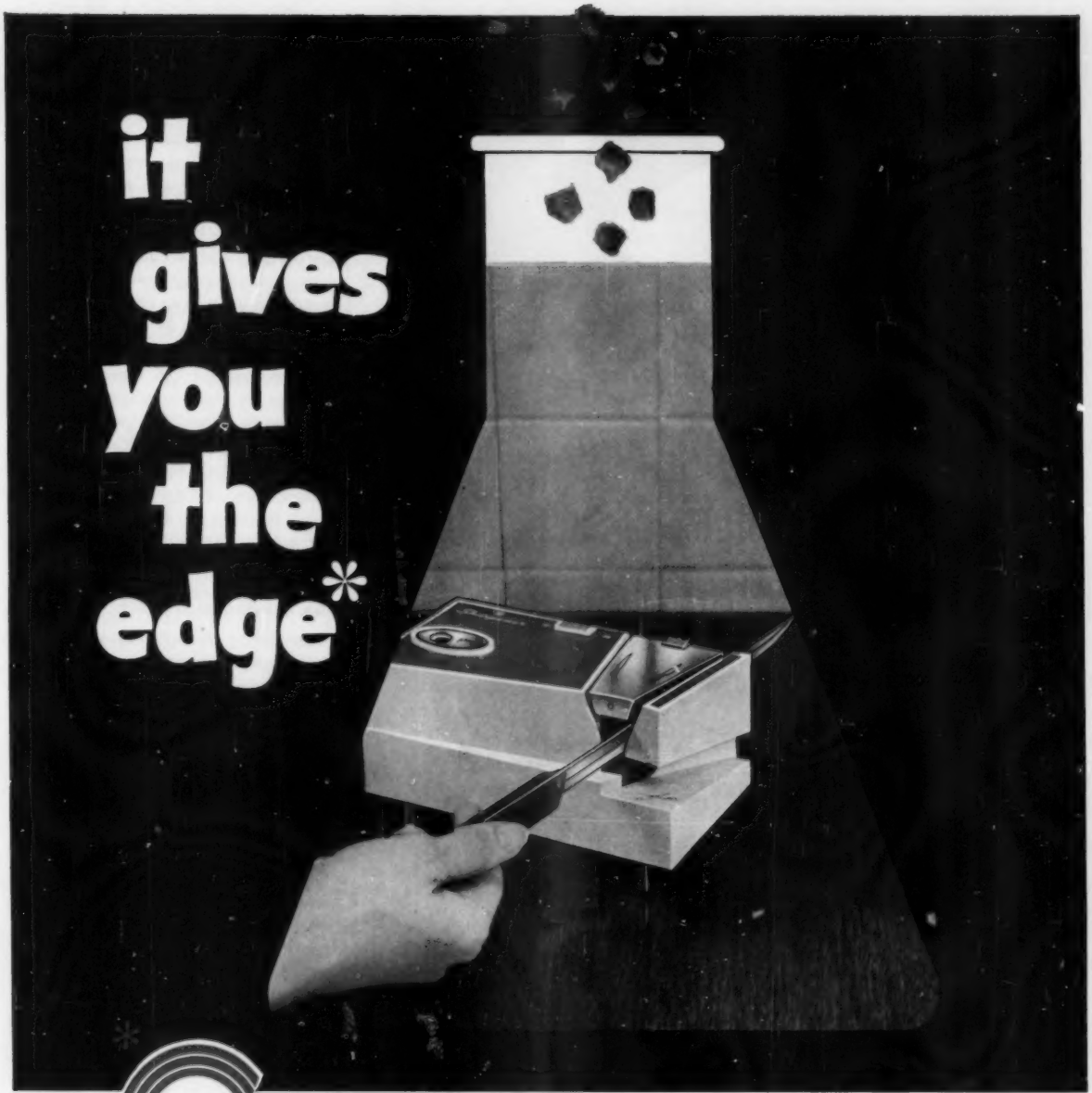
TFE fluorocarbon shapes. Available shapes and sizes of Teflon sheets, tape, rods, tubing, bars, and cylinders. Catalog TFE-359. 8 pages. *Cadillac Plastic & Chemical Co., 15111 Second Blvd., Detroit 3, Mich.*

Nylon. "Importance of Moisture Control in Processing Spencer Nylon" summarizes some recent tests conducted to determine the possible effects of moisture both during and after processing. 4 pages. *Spencer Chemical Co., Dwight Building, Kansas City 5, Mo.*

Plastics machinery. Five bulletins, 1 page each, outline sizes available, specifications, etc., for the following equipment: pipe pull-off unit, used for pulling IPS plastic pipe and/or large diameter rigid pipe or tubing; pipe coiling unit, used for coiling thermoplastic pipe or tubing with similar coiling characteristics as PE material; capstan, used for haul-off on numerous shapes of flexible materials and rigid shapes; water cooling tank, used for cooling of varied thermoplastic strips and shapes; and extrusion belt conveyor, used for conveying and cooling varied thermoplastic shapes and strips. *Miller Industries Inc., Elkhart, Ind.*

Thermoplastics. "Developments in Plastics" indicates the research and development facilities available, and describes the variety of thermoplastic products and their applications. 22 pages. *BX Plastics Ltd., Higham Station Ave., London E4, England.*

Industrial plastics. Brochure discusses properties and availabilities of a line of plastics mill shapes and machined parts, tubing and hose, sintered plastic parts, molding resins, and plastic coatings. 16 pages. *The Polymer Corp., Reading, Pa.*—**End**



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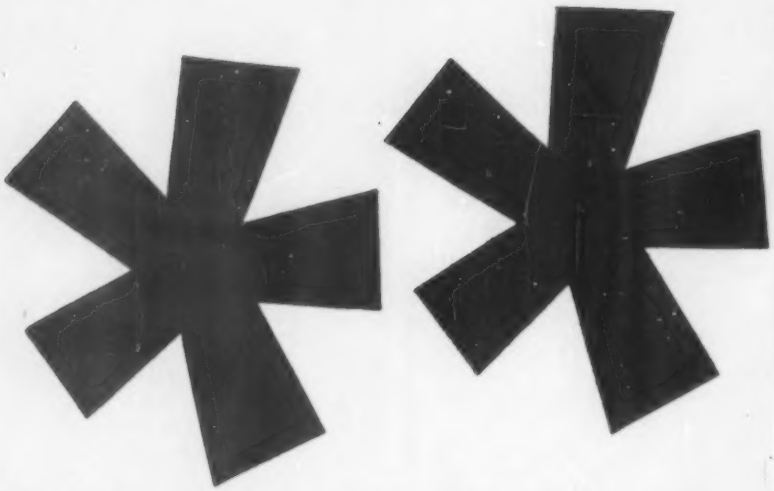

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Polypropylene

(From pp. 72-76)

The molecule is much stronger lengthwise than across its diameter so oriented PP has tensile strength of about 70,000 p.s.i., as compared to less than 5000 p.s.i. when unoriented. This helps to account for the tremendous flex life of a properly molded integral hinge. If the mold is not gated to take advantage of this alignment of molecules the hinge will be useless. In the case of monofilament and film, this orientation is done mechanically by stretching after the polymer is cooled below its melting point. An unoriented section has low-temperature deficiencies; in oriented sections the low-temperature strength is virtually as good as at room temperature.

The coming markets?

Estimating for possible division of polypropylene into various uses for the next few years has furnished a field day for analysts. There is no clear-cut pattern as yet. The estimates given in the table on p. 75 have been made by one of the more optimistic industry producers.

The greatest difference in opinion among estimators is in the amount of PP to be used for textiles. Most analysts seem to feel that such use will be barely off the ground by 1965 but will come along strongly in the late 1960's and could then reach the 100 million lb. which the table predicts for 1965. Synthetic fabrics have seldom developed big volume in such a short time and it is doubtful that PP will move much faster. However, it is potentially one of the lowest-cost fibers ever made available and once it becomes established growth could be extremely rapid. Some analysts state that multifilament yarn consumption in 1965 will be no more than from 20 to 50 million pounds. If the table's 100-million-lb. estimate for textiles in 1965 should be fulfilled the danger of feared overcapacity in that year may be alleviated. It is interesting to note that companies with textile experience, such as AviSun, Texas-Eastman, Hercules, Du Pont, and Montecatini are particularly interested in PP and could have more back-

ground knowledge or confidence in its future.

Other areas in this table that could be called problematical are wire and cable, coating, blow molding, and pipe. Up to now there has been little commercial application of PP for these uses. More work must be done on both resin and processing technique, but producers all feel these applications are possibilities. One paper company thinks PP coating should have great value on corrugated box board. A big wire coater thinks foamed PP may become extremely useful to him. Initial enthusiasm in pipe has cooled off and producers of blown bottles have not yet evinced much interest in the resin. However, development work is going on in all these fields.

The export field is almost a minus prospect at this moment. Capacity in foreign countries is now or soon will be between 250 and 300 million pounds. There seems little chance of a big export market like that which has been such a boon to the polyethylene market. Indeed the Americans may have to worry about imported resin in years to come, especially if foreign producers fail to market their total production in local areas. Few observers estimate export potential will be as much as 20 million lb. in 1965 (see table on p. 75).

There are so many possibilities, both good and bad, in the film and injection-molding categories that the final figures given in the table could be either well above or below the printed estimates. Several big-volume applications could develop, such as that which boomed high-density PE when the detergent bottle came along. Bread wrappers for film is an example. A few more applications like the luggage case and television backs could move a lot of PP. Note that the estimates for injection molding show only a modest growth 1961 and '62, but a big jump from then on. This could be due to the producers' emphasis on use of PP as a replacement for leather, wood, metal, etc., rather than as a replacement for other plastics. This trend should begin to make good headway by 1963 or '64. So far there is no indication that polystyrene and polyethylene producers are overly worried about losing their molding markets to PP—they have property and price qualities that PP cannot match.

The film situation produces more variation in the future markets guessing game than any other. There is no question but that either cast or oriented PP film has properties such as clarity and barrier resistance which are superior to other films, but price, production problems, and machine handling may hold it back. And in some areas, such as bags, PP may never move in. The problem of handling on wrapping machines could be overcome when more satisfactory machines are built—but such a machine would also handle polyethylene more efficiently. The first goal for PP film was to move in on cellophane, but the cellophane people have already countered with what amounts to a reduction in price and they doubtless have other plans. It will be a long time, if ever, before PP takes over a major portion of the

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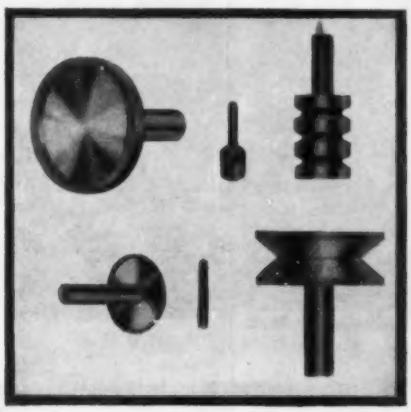

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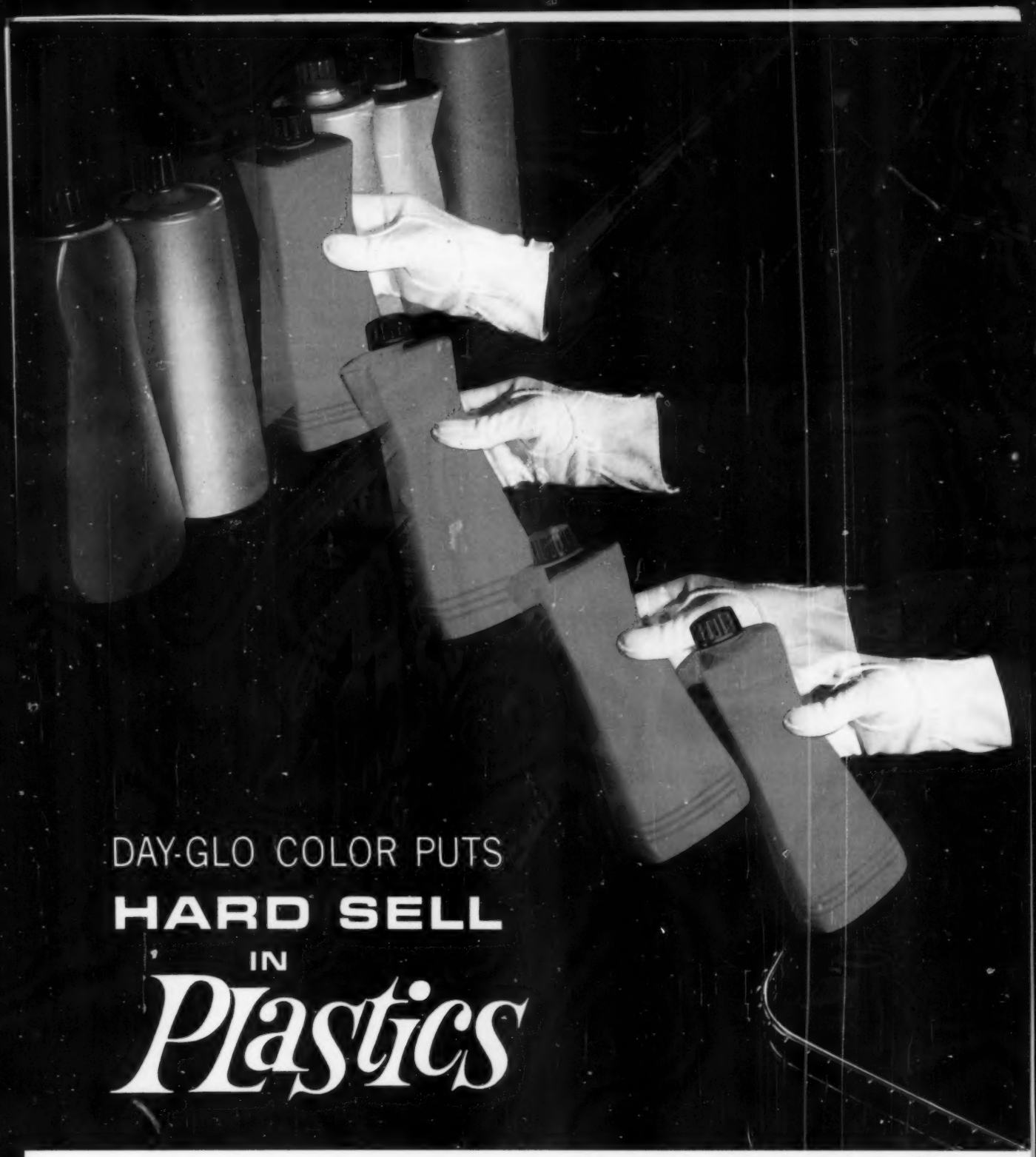
cellophane market. The recent drop in PP film price seemed to be aimed just as much at polyethylene bread wraps as at cellophane and it could be that PP film will cut into some PE markets more than it does into cellophane. However, the entire flexible film market is on a big upward spiral and it is probable that there will be good markets for all.

One company sales manager points out that the use of PP with other materials either as a copolymer or as an additive, mix, blend, etc., could be one of its most important uses. This prognostication cannot be pinpointed at this time, but it is a development that bears watching. The producer of PP can vary molecular weight and molecular-weight distribution to give a variety of formulas or he can use additives such as polyisobutylene, rubber, and many other polymers, or he can copolymerize. The use of polyisobutylene with PP in luggage to give added toughness is a good example. The same man stated that polyethylene is in the minor leagues compared to polypropylene when it comes to the number of modifications and formulations that can be produced and woe be unto the processor who doesn't learn about this from both a processing and marketing point of view.

And once more it is necessary to point out that price is a major factor in judging the estimates in the market table. Polypropylene will never reach those 1965 estimates if it remains at 42¢/pound. The timing of price reductions and extent of the decline will probably be among the more important determinants in charting the course of PP for the next 5 years. Again to quote a sales manager: "Even if we aren't sure where the best markets will develop we *are* sure that the combined qualities of potential low price and low density present a situation that is certain to develop polypropylene into a big-volume plastic."

The capacity table on page 75 is only intended to give a rough idea of the capacity situation. Some companies won't comment on potential capacity and there are still others who may get into the business that haven't yet been committed. Then there is the case of



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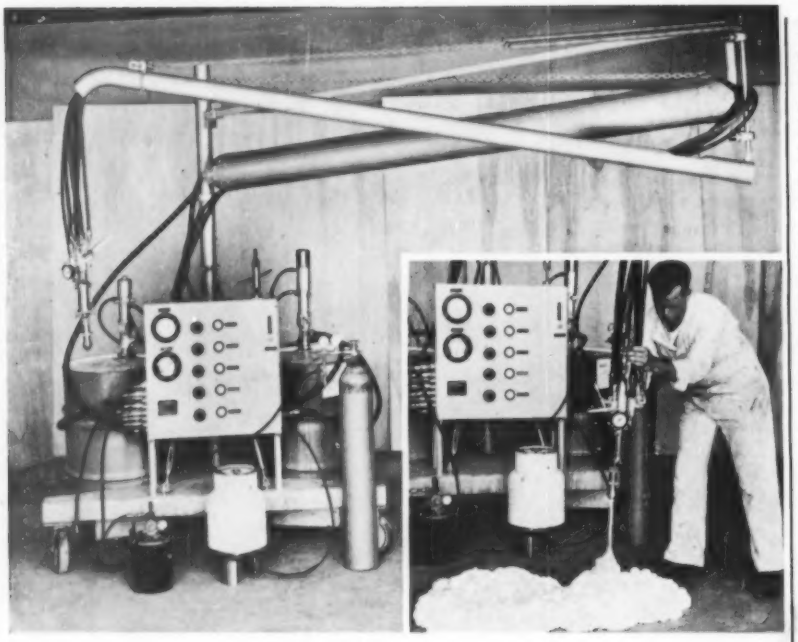

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Humble Oil, for example, which operates a 40-million-lb. plant but has plans for expansion to 100 million lb., just as soon as the market will take it. The idea here is to convey the thought that 1) total capacity is going to be over 500 million lb. in 1965, 2) that capacity will be far ahead of consumption in 1962, but 3) that a closer relationship between the two will emerge in 1965 unless more companies come into the picture and provided that PP multifilaments are ready to roll by that time.

An interesting feature of this capacity situation is the arrangement made by various producers to furnish resin to other companies who otherwise might have entered production but instead have chosen to buy resin for resale and concentrate on market development until they become more familiar with polypropylene's possibilities. This move was probably one of the smartest efforts ever made by the chemical industry to control partially, at least, ruinous over-capacity.

These arrangements are between Enjay and Spencer; Shell and Union Carbide; Hercules and Du Pont; Novamont and W. R. Grace; Dow and Monsanto. Rexall too has reportedly made arrangements to buy and sell AviSun's resin but will also buy from other companies. If polypropylene grows as fast and gets as big as expected it is likely that some or all of these companies who are now buying resin for resale and development will build their own plants. It is also likely that at least two of these firms will be in production by 1965.

What about PP patents?

The patent situation in polypropylene for the U. S. is about as foggy as it can get. There are five companies reported to be involved: Du Pont, Standard of Indiana, Phillips, Hercules, and Montecatini. It is strange that only Hercules of this group is producing resin, although Montecatini (Novamont) will soon be in. Tennessee-Eastman claims two processes that will infringe no one's patent. Shell has been noncommittal, but is building a polypropylene plant with Montecatini in Holland and works under a license with Ziegler in

England to produce linear polyethylene and/or propylene in England. American companies have gone ahead with their production regardless of the patent situation believing that they would be too late if they waited for the patent situation to clear up and making allowance for payment of royalties.

A brief summary of the American companies now making or who might make polypropylene in this country is as follows:

Allied Chemical. No information except a brief announcement that it expects to enter the field. Pilot plant samples are in circulation.

Amoco. No comment, but the company has shown considerable activity in surveying the field.

AviSun. A joint arrangement between Avisco and Sun Oil is just beginning to operate a new resin plant in New Castle, Del., with a reported capacity of 100-million-lb. but which could be more. The company has operated a 20-million-lb. plant at Port Reading, N. J., for several years. It was part of the Koppers linear PE plant. There apparently is no decision as yet on whether or not AviSun will continue to operate this plant. The company will reportedly sell resin to Rexall. Shulman is also a distributor for AviSun. AviSun was the second U. S. company to start producing PP on a commercial scale, and is also producing film, called Olefane, at the New Castle plant. Since Avisco, a parent company, is a producer of cellophane and synthetic fibers it brings special knowledge to the industry pertaining to film and textiles. Tradename of company's PP is AviSun Polypropylene.

Firestone. Company reports its plans are not definite at this time. As an extruder of Saran monofilament, Firestone could be particularly interested in this area of polypropylene development.

Dow Chemical. Position is complex. The company has various low-pressure PE operations but the plant in Torrance, Calif., is primarily for PP. An approved plant in Louisiana is primarily for linear PE but is also capable of making PP, as is the operating plant at Bay City, Mich. Another plant under construction is primarily for copolymers but could make either PP or linear PE. The company has a linear PE plant in Sarnia, Canada; this, too, could produce PP. The company also has a sizable PP pilot plant at Midland, Mich.

Dow is an expert in ethylene chemistry and doesn't aim to watch the polyolefins parade pass by without getting in. Also, one-third of Dow's sales are in the plastics field—the company expects to maintain that position and is not going to pass up potential big volume plastics. Dow will sell PP to Monsanto, which will use it for development purposes and to become familiar with the market with the prospect of entering the production field later.

Hercules was first American PP producer and played the primary role in development of the first stabilizer systems to prevent rapid oxidation. Started commercial production in Dec. 1957 in a unit where low-pressure PE was also produced. This unit has now been reconverted to polyethylene and the company is operating a 60-million-lb. PP plant in Louisiana with plans to add 60 million lb. to capacity in 1962. The company was working on development of polypropylene long before the announced discovery of PP in Italy, utilizing research findings developed from catalysts which Hercules had licensed from Ziegler some years before. Close cooperation with Farbwerke Hoechst of Germany was established and joint development work carried out. Hoechst had been among the foremost in development of Ziegler-type low-pressure PE. Hercules PP tradename is Pro-Fax. It is also distributed by Catalin Corp.

Hercules also sells PP to Du Pont. The latter expects to do development work and gain knowledge of the market before building its own plant and may ask Hercules to produce special formulas. Engineering and cost studies have not yet been completed but if all goes well, Du Pont should have a plant before 1965.

Humble Oil & Refining Co. Is owned by Standard Oil Co. (N. J.) and

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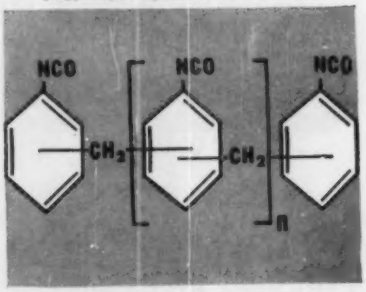

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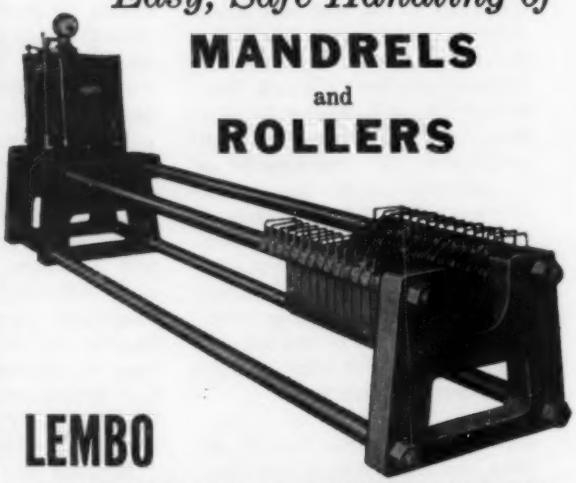

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is producing PP in a 60-million-lb. plant that can be expanded to 100 million for Enjay, which is now the division of Humble responsible for planning, growth, and marketing of petrochemicals. The parent company, Standard, has been a pioneer in petrochemicals, is prominent in production of many types, including polyisobutylene and isooctyl alcohol, which are well known to plastics operators.

Humble built a 40-million-lb. PP plant in Baytown, Texas, that started polymerization in Jan. 1960, began selling through Enjay in May of that year. Sales and technical service is handled by Enjay laboratory. Enjay is restricted in marketing to U. S., foreign marketing is done by Esso International. Tradename for PP is Escon.

Enjay entered into an agreement with Spencer in 1958 to sell a portion of the Humble PP output. The Spencer tradename is Poly-Pro.

Novamont. Is a subsidiary of Montecatini of Italy. Chemore, the general representative of Montecatini in the U. S., will sell PP produced by Novamont at Neal, Va., in a 25-million-lb. plant with plans for expansion. Production is scheduled to begin this fall. The tradename is Moplen.

Montecatini states that it holds patents on composition of matter and/or process in 42 countries outside Italy and has issued 11 licenses to produce PP in England, France, Austria, Netherlands, Scandinavia, Japan, and the U. S. Applications for U. S. patents have been made. Montecatini has a 40-million-lb. capacity plant in Italy with another one building and a 12-million-lb. fiber plant that will be increased to 60 million in 1962. Its joint ventures with companies in countries other than Italy have a capacity of over 80 million pounds. The company also produces an ethylene-propylene copolymer elastomer, or rubber, called Dutral.

W. R. Grace has made an agreement with Chemore to sell a certain amount of the Novamont PP output in the United States.

Shell Chemical. An 80-million-lb. PP plant is scheduled to start production for Shell at Burlington, N. J., in 1962. Shell also has a Ziegler license to make polypro-

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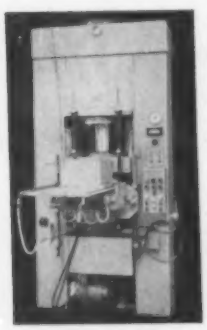

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pylene in England, is building a PP plant with Montecatini in Holland, and operates a polyolefins film plant with Kordite in England.

Shell, too, is a pioneer in the petrochemicals field and has been especially active with those chemicals used by the plastics industry. Earlier in the year the firm announced an arrangement with Union Carbide whereby the latter would sell Shell polypropylene and Shell would sell U. C.'s PE.

Eastman Chemical. Brought in a 25-million-lb. plant in Longview, Texas, last spring that can probably be expanded quickly. Eastman has two processes which it considers patentable but has never divulged the differences between them except to say that the Kingsport laboratory version is a "stereosymmetric" polymer that can be sold both in the U. S. and abroad. Both processes are asserted to be both free and clear of the U. S. patents of others.

The company asserts that its resins have higher flow rates than other polypropylenes and that they can be furnished in the widest variety of impact-resistant formulas. The low ash content also allows the use of higher concentrates of antioxidants. Eastman has also had years of experience producing ultra-violet inhibitors and has applied this knowledge to obtain better sunlight-resistant properties. Tradename of Eastman's product is Tenite Polypropylene.

Phillips Chemical. Has done extensive pilot plant work for manufacturing PP which is asserted to have demonstrated technical and economic advantages. Company is now evaluating these resins. Decision as to authorization of a Phillips plant for commercial polypropylene awaits completion of a program of end-use tests on the pilot plant products.

Rexall. No information on current situation although statement was made a year ago that the company expected to build, with El Paso Natural Gas, a polypropylene as well as PE plant.—**End**

* * *

Part II in this series, dealing with polypropylene applications, will appear in a forthcoming issue.

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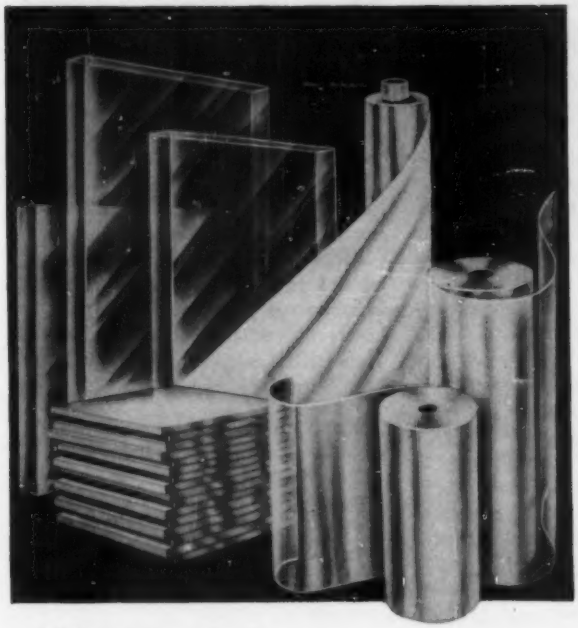

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PVC		X	X	X	X
Polypropylene		X	X		
Polyethylene—Regular	X	X	X	X	X
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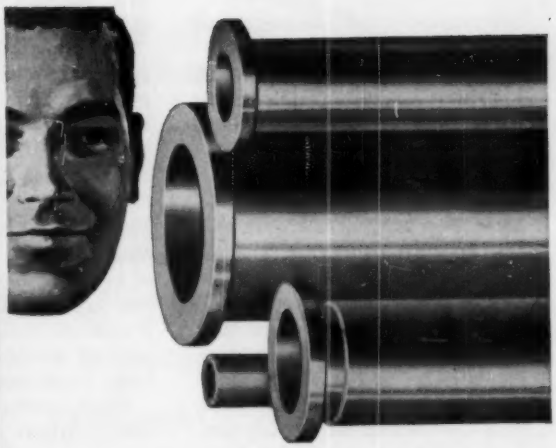

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(*From page 85*)

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The primary reason for selection of prepreg was quality control, the even distribution of polyester resin and glass reinforcement possible with prepreg. Moreover, this material uniformity and quality is reproduced in every hard harness unit, which eliminates rejects and cuts scrap loss to a minimum. The use of prepreg has also meant production costs estimated by company production men to be one-third the cost of hand layup—because of faster production speeds possible.

Glass cloth, pre-impregnated with polyester resin in a 50-50 ratio, is supplied to the aircraft builder in easy-to-handle rolls. Prior to shipment, the material has been advanced to a stable "B" or partially-cured stage. The prepreg is cut to specified dimensions (there are 11 individual harness shapes), and three plies are fitted into the lower section of a split female metal mold. Wiring cable is pushed down into the mold and the prepreg folded over the top, overlapping to form six plies. Several extra wires are fitted into the mold to provide for possible later installation of additional electrical equipment or alternate circuitry in case of wire failure. The upper section of the mold is clamped in place, electric heating started, and the harness is cured at 250°F. for 1 hour.

At the present time, the molded prepreg harness is only used to encase wiring in the Crusader jet. However, the compactness, strength, and upgraded electrical performance afforded by the new harness in this application make it a potential answer to electrical problems in other aircraft and commercial vehicles, computers and other electronic gear, and in wiring for factories, homes, etc.

Credits: Hard wiring harness developed and molded by Chance Vought Corp., Dallas, Texas, using polyester-glass prepreg material supplied by Cordo Molding Products Inc., New York, N. Y. Data for this article was supplied by the Prepreg Div. of the Society of the Plastics Industry Inc.—**End**

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Beverage cases

(From pp. 88-91)

cases, is truly surprising. Several reasons have been adduced to explain the slow start, all of which are susceptible to solution:

Who'll be first? One of the major obstacles to sales is the fact that no dairy seems to want to be the first in its area. "Who else is using it?" is a typical response to the first sales effort. Little can be done on this, except continued presentation of the facts, until the normal inertia of dairies is overcome and the case accepted by a major bottler.

Pilferage: Because of the attractive appearance of the cases, many milk distributors feel that they may incur losses through customers or route men taking off with them. Again, this is a tough objection to overcome. But suppliers point out that if pilferage turns out to be a serious problem (which remains yet to be seen, since perforated bottoms limit the utility of the cases) most areas will reach a saturation point very quickly, beyond which this problem will cease to exist. Wooden cases have had a long history of pilferage. They are frequently taken for use as fire wood . . . which means a continuous demand. Polyethylene cases, of course, can't be put to such use. To help keep pilferage to a minimum, Baker Box Co. places decals with this message on two sides of its cases: "Warning . . . these cases protected by John Burns, International Detective Agency."

The case for soft drinks

While they may differ in detail, all the advantages cited for the high-density PE milk case apply equally well to recently introduced soft-drink cases. There are two important differences, however. One is the fact that these cases, unlike the milk boxes, will be used for home deliveries as well as deliveries to retail stores. This places an extra value on their merchandising and cleanliness appeal.

The other difference which many observers regard as very significant, is the fact that Union Carbide Plastics Co. is selling them. For UC to enter the finished plastic product business is a major indication of the potential market for these cases. Moreover, it is felt by many that with UC behind this product, its chances for success are considerably improved. There is a feeling in the trade that Union Carbide is acting as a market leader in this instance, hoping to establish the soft-drink case market for resin. Although for the time being, the company is the only supplier of such cases, Consolidated Molded Products, Scranton, Pa., is said to be developing a PE soft drink case.

Baker Box Co. also has been developing a soft-drink case for the past 18 months and plans to be in full production by the end of the year. Material used is expected to be Marlex high-density resin; and the cases will incorporate a special bottom treatment to prevent slippage in transit.

Two types of UC cases are made: a 4-cell case for 12-oz. bottles and a 24-cell case for 6½ and 7-oz. bottles. They weigh 2.2 lb. and 2.6 lb. respectively. Price per four-cell case is $1.50 in quantities of more than 10 pallets (one pallet equals

140 cases). Price per 24-cell case is $1.75 in quantities of more than 10 pallets.

Both four-cell and 24-cell cases are produced in the same general sizes (outside dimensions are 18½ by 12 by 4⅝ in. and 18½ by 12 by 4⅛ in., respectively) as wooden units currently on the market, and all three can be used interchangeably on case-loading automatic bottling equipment.

As with the milk case, the merchandising appeal represents a strong plus. Union Carbide handles this problem by providing logos in three colors of any nationally franchised brand, printed on vinyl and attached to the cases with pressure-sensitive adhesive. The cases are designed with recesses along the sides to accept these labels and protect them during use. Cost of the cases includes labels.

Wooden cases for this application cost from 90¢ to $1.25, and in addition require on an average of 45¢ to 60¢ in repair and repainting during their service life (rule-of-thumb for maintenance cost is generally 50% of initial cost). Again, considering the fact that the units will outlast wood by a factor of about 2:1, the economic advantage on a price-service life basis is clearly in favor of PE cases. While the exact service life of the new units has not yet been established, the cases carry a 5-year guarantee.

The material used for the Union Carbide cases is Bakelite high-density PE compound, which contains both an anti-oxidant and an ultra-violet light absorber. Density is 0.960 and melt index is 3.5. The Union Carbide cases are molded by Nosco Plastics in single-cavity, multi-gated molds.

The case for beer

As a replacement for fibre-board boxes, the molded high-density PE case for beer is perhaps the most ambitious of all the beverage applications; ambitious because in terms of initial purchase price, the new cases cost perhaps three to four times as much as the ones they replace. Yet they are expected to establish a firm market.

Prime reason for this expectation is long service life. The paper-board containers are good for only about 3 to 15 trips, the lower end of the scale applying especially in humid areas. Frequently, a single trip is all they will take. The plastic case, on the other hand, may be good for as many as 100 trips; one supplier is even talking about 200 trips! Thus, in terms of long-range economics, the new case turns out to be more economical.

In addition to this important feature, the beer case again provides all the secondary advantages cited for the milk case.

Duquesne Brewing Co., Pittsburgh, Pa., is the first major brewery to use the new cases. After three years of research and development on its plastic beer case, Duquesne is now conducting an extensive market test of the case on two of its products. Previously, two smaller tests showed an all-time high in impulse buying due to the new case.

As can be seen from the photo (p. 91), the firm has made extremely good use of the merchandise and display advantages of the plastic case as compared to fibre-

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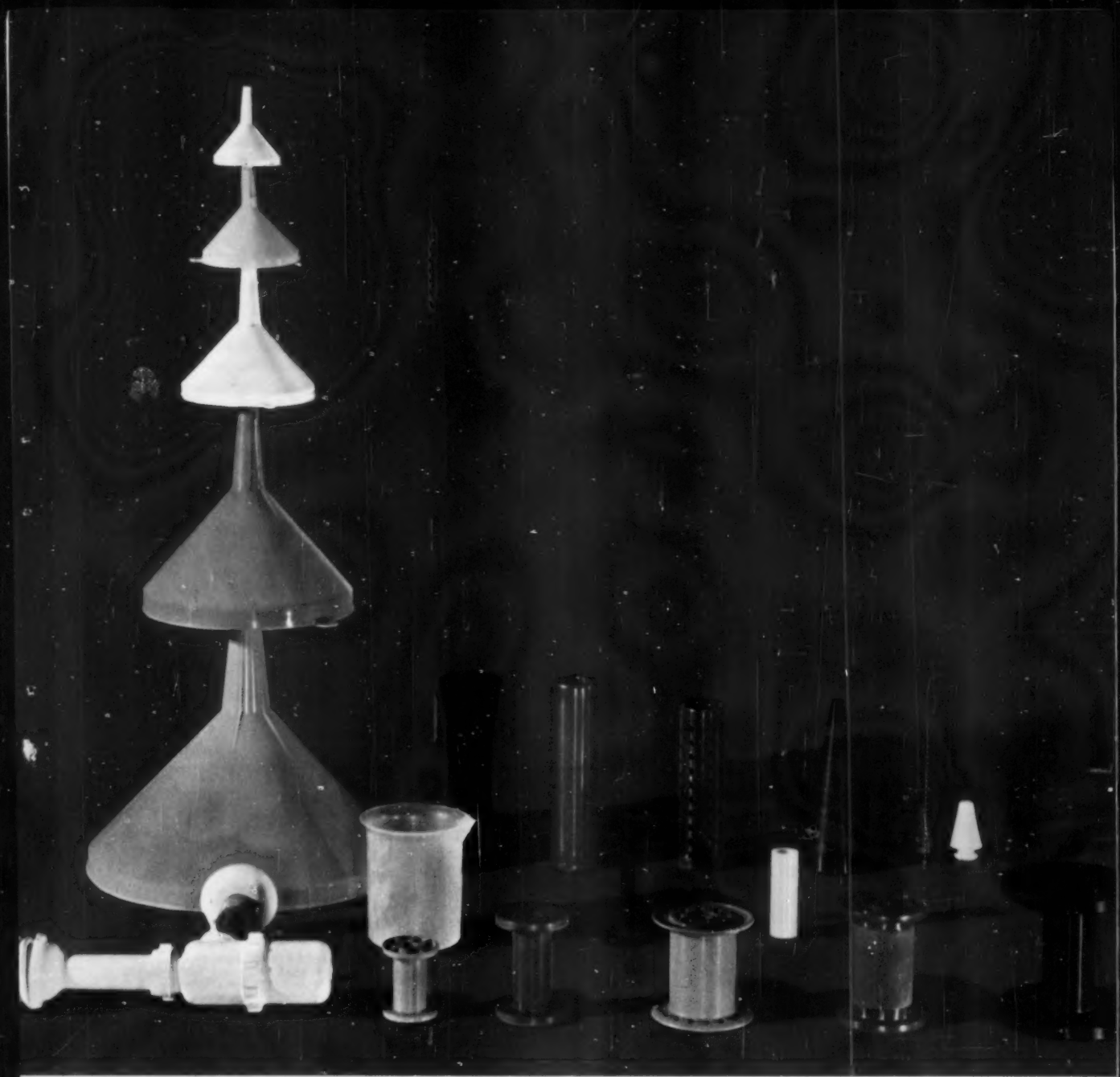

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The new case, which weighs 3 lb., is molded for Duquesne (which has patents pending on it throughout the free world) by Panelyte, using Super Dylon high-density polyethylene. The resin has a density of 0.953 and a melt index of 3.0. The case is molded in one piece with integral continuous hinges and double-lid. It should be noted that this is not only a 3-lb. shot, but is also a molding which has a projected area of almost 400 sq. inches, truly a technological feat to produce. Approximate price is $2.00 per case. Paper-board egg crating is used to position the bottles, and is replaced for each trip. Cost of this insert is 2½¢ per trip. Logos are printed on all four sides by means of hot stamping, involving perhaps the largest dies ever made for foil leaf stamping. The dies, measuring 12¼ by 9¼ in. and 6⅞ by 6⅜ in., are manufactured by Jas. H. Matthews & Co., Pittsburgh, Pa. (see photo, p. 91).

Another entry in the beer case derby is the version offered by Union Carbide Plastics (photo, p. 91). Molded for the company by Nosco, of Bakelite high-density material, the case weighs 4.3 pounds. It differs from the Duquesne case primarily in that it has molded-in egg crate dividers. This case, too, is molded in one piece and is double lidded. It has a molded-in hinge which is intermittent rather than continuous, to prevent any damage from propagating along the hinge.

Both beer cases are so new, that no firm prices have been set; but as stated above, they are expected to be competitive with fibre cases, once all factors are considered.

What is the outlook?

High-density PE beverage cases have been in the development stage for about three years now. During that time, many engineering and design problems have been encountered and solved. Prototype units were placed in dairies, soft-drink bottling plants, and breweries and tested. Designs and molds were modified to meet every requirement encountered. The cases that are coming to market today are the result of this painstaking effort: they are well designed, highly engineered, and proved out in actual use tests.

But they represent more than just one new market for PE; they presage still further market expansion for the material, *viz.:* tote boxes. A typical market would be fruit collection boxes for orange plantations, cases for hands of bananas (one such version is currently undergoing test), and similar applications. Considerable work is being done right now to establish the economics in each instance and preliminary results indicate that these fields will go to high-density. And when they do, watch out for a real market explosion in high-density polyethylene.

Credits: Makers of the molds for the large area pieces described are: for Panelyte cases, Akromold Inc., Akron, Ohio; for Dunning cases, Major Mold & Tool Co., East Detroit, Mich.; other molds made by molder.—**End**

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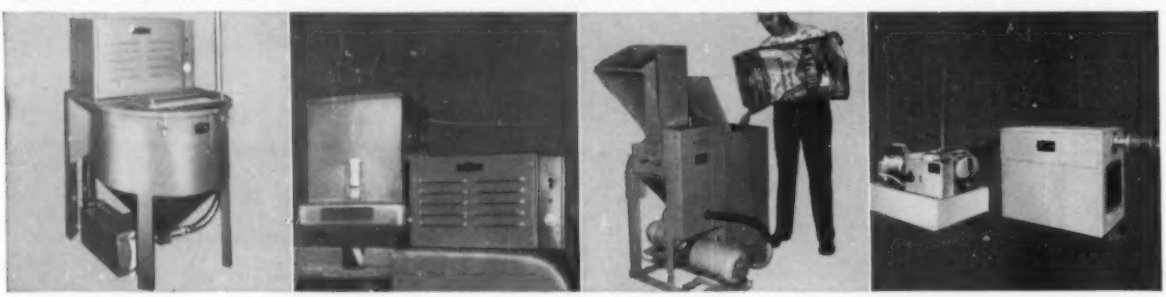

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No-sag design

(From pp. 77)

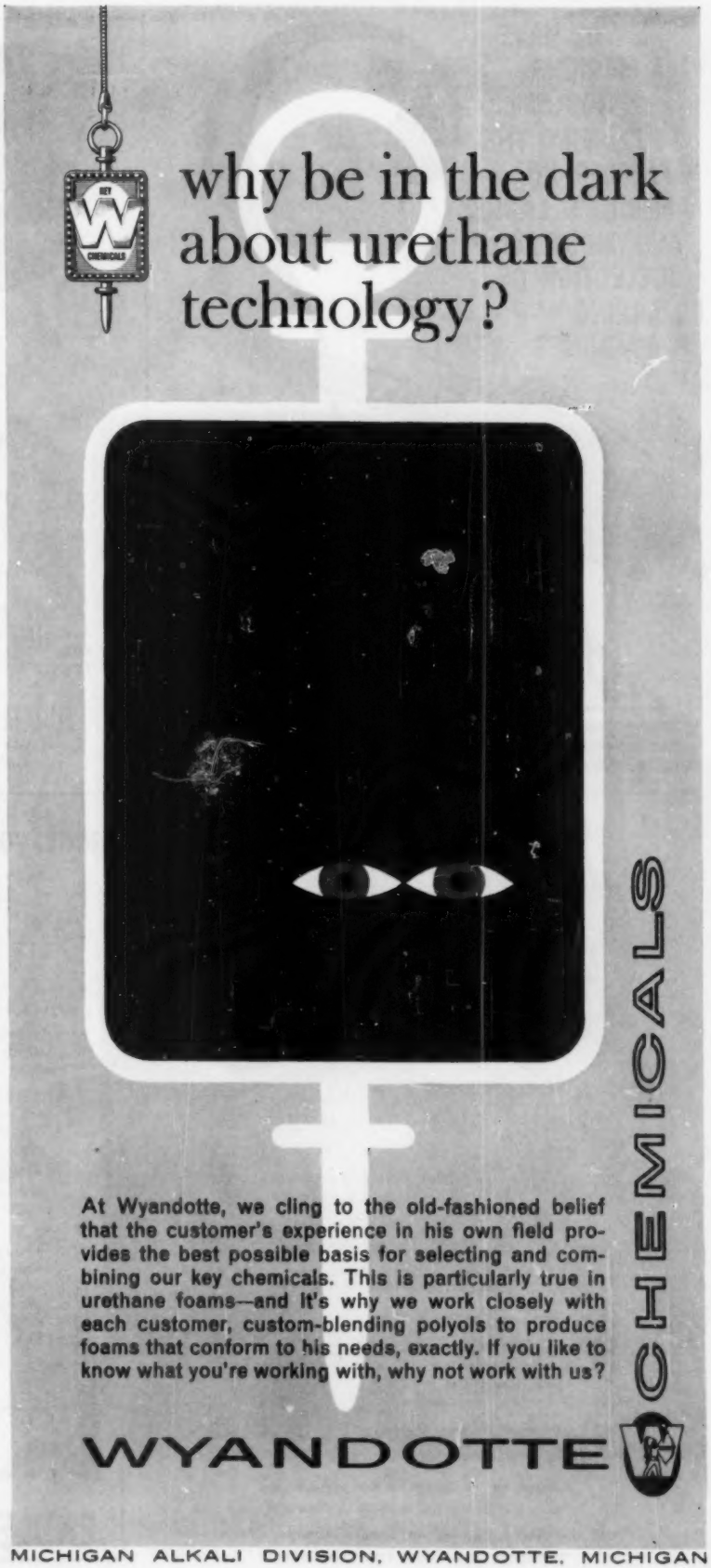
along the length of the blades. A tapered design was called for—but how could it be achieved economically? One manufacturer's solution: "building up" his blades with thin layers of phenolic-impregnated, cotton fabric-base laminate. The blades are thicker by several laminate layers at the shank end, and taper down to their thinnest point — where the least bending stress is encountered—at the tip. The leading edge of the blade is reinforced with six or seven tapered laminated layers.

An important factor behind the success of this method is the availability of laminate sheets in over-standard sizes, which minimizes scrap loss for greatest production economy. In this application sheet sizes range from 49½ by 96 in. to 49½ by 108 in., and thicknesses range from 0.094 to 0.125 inches. The blade shank is made from phenolic laminate blocks 2⅛ in. thick.

Each blade begins as 9 or 10 templets of different length cut out of the laminate sheet. These thin sections are run through glue rolls, where they are coated with a layer of phenol-resorcinol adhesive. The templets, with ends aligned at what will be the hub of the blade, are then placed in a steam-heated forming die. Steam and pressure over a 2-hr. period sets the adhesive and contours the blade.

The blade shank, consisting of two pieces cut from laminated blocks, and the hub end of the blade are bonded together by means of adhesive and held by seven stainless steel bolts. Next, the six or seven laminate layers are bonded to the blade's leading edge for reinforcement, and the adhesive cured by oven heat. The entire blade assembly is then mounted on a lathe and the square shank machined into its final circular shape. Finishing step involves grinding of the stepped-down laminate surface until the blade surface is smoothed and the blade is reduced to a specified weight (from 38 to 135 lb.).

Credits: Fan blades made by Hartzell Propeller Fan Co., Piqua, Ohio, from Micarta Grade 262 laminate sheets supplied by Westinghouse Electric Corp., Micarta Div., Hampton, S. C.—**End**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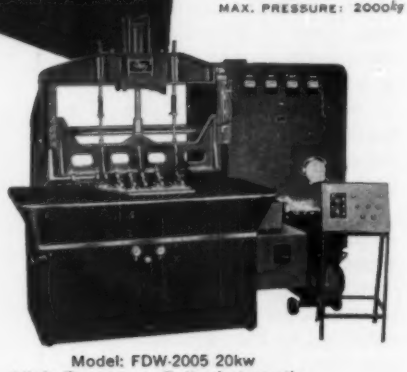

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Army shelter

(*From pp. 78-80*)

spray equipment, after a short training period.

4. The mold was closed. With the mold positioned on edge, the foaming resin was introduced through four charging holes in the upper edge. The majority of the molds were filled by means of a mechanical dispenser. For experimental purposes the remaining molds were filled using an improvised hand mixing set-up. The machine dispenser was of 15 lb./min. capacity. The hand mixer was of 15 lb./min. capacity. The hand mixer was improvised by fastening a stirring rod on an electric drill motor. The foam rise took approximately 4 min. with a cure time of 1 hr. before being removed from the mold.

Why RP-foam combination was used

The original shelter concept envisioned using a panel fabricated entirely of foam. However, it became apparent that the foam skin would not be able to withstand the abrasive action to which the shelter would be exposed. Experiments are being made using either nonfoaming polyurethane or polyester resin as a first layer. The so-called "leg-bone" foams which harden with a greater skin density also show promise in this direction. For stressed skin applications, the fibrous glass-polyester coating appears to be the best material now on hand that can be combined with foam. On the first series of panels, the skin coating was applied after the panels were removed from the molds. This method resulted in poor adhesion between foam and RP surface because of the residue of parting compound adhering to the foam. The subsequent method of application of the fibrous glass to the interior of the mold resulted in an excellent bond between the laminate and the foam, and produced a panel surface as smooth as that of the mold interior.

Until a better skin than glass-resin laminate is found, a fibrous glass-resin depositor similar to the equipment described is a production improvement over hand lay-up methods. This particular apparatus works best on horizontal surfaces, although vertical surfaces can be

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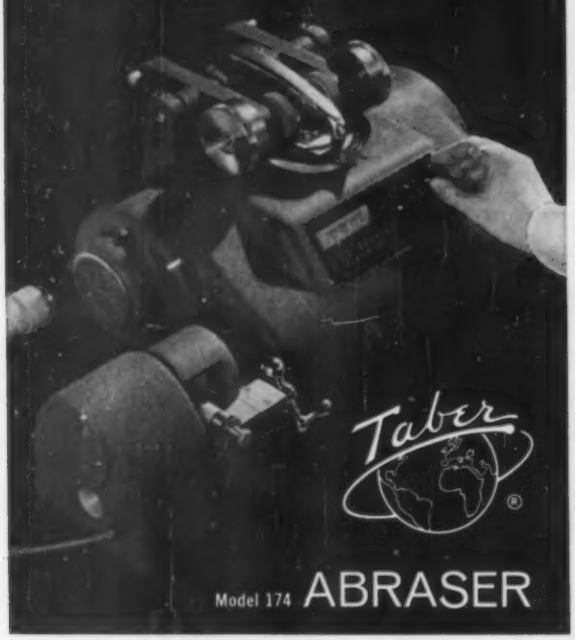

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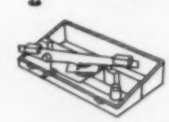

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sprayed by an experienced operator with a helper rolling the material out as it is applied. Although the present depositor is not capable of depositing on overhead surfaces because of low-velocity propulsion of the fibrous glass, it is understood that subsequent models will incorporate this improvement.

The concept of using low-bulk materials dictated that the first experiments be conducted with a polyurethane foam of a density of 2 lb./cu. feet. Foams of higher density would have much better strength and abrasion resistance, but considering that even a 3-lb./cu.-ft. foam would increase shipping weight by 50%, there was great reluctance to use high-density foam in this first effort.

Flame retardant additives are easily incorporated in both the core foam and the skin laminate. Samples of foams so modified check out favorably. Additives of this type are slightly detrimental to some characteristics of the foam but these can be bolstered by modifying other components of the formulae. Polyester resins with built-in fire retardance yield a somewhat heavier laminate.

The activation times of the foams used were quite satisfactory having a rise time of approximately 4 min. and a cure time of 1 hr. before removal from the mold. Under optimum conditions the production time for the panels is 4 castings per mold per 8-hr. day. Two men adequately trained should be able to service one mold, including the application of the glass fibrous-reinforced skin, and maintain this production rate.

Mixing techniques

In investigating possible methods of production for the shelter many variations of technique were used in mixing the foam and in casting the modules. But automatic metering equipment proved quite necessary for fast production. The machine used in this work was an excellent piece of equipment, but its capacity of 15 lb./min. was inadequate for the casting requirement of the molds which averaged 22 lb. of foam each. Castings obtained by hand mixing were tolerable for the purpose. It is evident that further study will be necessary before good homogeneous castings can be pro-

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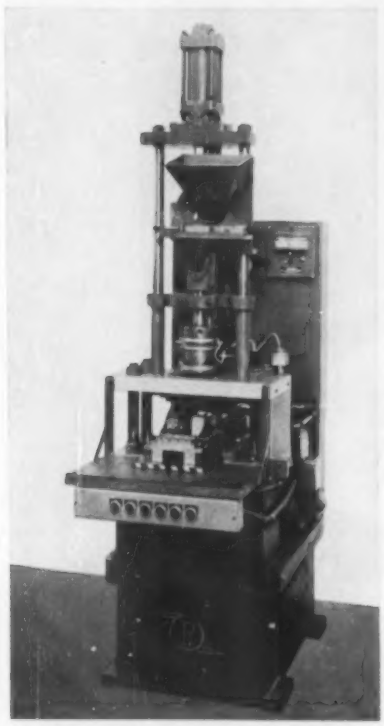

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duced consistently by this method. Although smaller casts in lifts or layers resulted in a better product and showed excellent bonding between layers, the experiments indicated that all the foam for a casting should be introduced as quickly as possible to obtain the most homogeneous structure.

There has recently come to the attention of the foaming industry a new technique known as "frothing." The foaming machine that we now have on hand is being modified for evaluation of this new technique. Briefly, the froth is produced by the introduction of another type of fluorocarbon or foaming agent, which creates a foam directly in the nozzle. The formulation emerges as a pre-expanded foam which completely fills the mold with little or no additional expansion. The attractive feature of this foaming system is that lesser pressures are created by the foam in the molds, permitting molds of lighter and less costly construction.

Future research and development

The first shelter modules incorporated in a complete structure were subjected to freezing temperatures for several weeks. Inspection after this exposure showed considerable warpage in several panels. Further investigation with smaller samples in cold chambers held to —40° to 60° F. has indicated uniform shrinkage in an acceptable range, and the conclusion at this time is that many of the rejects in the prototype were due to poor mixing or improper formulation, especially since some panels were unaffected. No comprehensive tests of high temperature resistance have been made, although samples exposed to temperatures of 150° F. show no adverse effects.

Problems that must be solved before the material may be readily used under field conditions with certainty include: 1) shrinkage or instability of foams under temperature extremes; 2) deficiency in fire retardance; 3) complexity of methods of mixing foaming components; 4) critical temperature range of foaming reactions; 5) need for precision proportioning or metering of foaming components. In addition to the above, further research is indicated to provide a foam which when cured will have both a skin tough enough to withstand normal occupancy abuse and weathering as well as to provide structural strength for the panel. This would allow the elimination of a separate RP skin. In the experimental shelter the material cost of the skin was approximately 30% of the total material cost. In addition the labor for applying the skin was approximately 70% of the total effort. The labor required for the fibrous glass-resin application requires a higher level of skill than does the labor necessary for foaming. A panel with a tough integral skin would also eliminate about 50% of the equipment requirements and two of the three major material components.

The current USAERDL development program also envisions the eventual design and production of a foam building which will be structurally integral and capable of withstanding the snow and wind loads that would normally be encountered. The panels could be designed to fit various climates by building the molds so that different thicknesses of wall could be produced to give the desired insulating value and structural rigidity. This would result in the optimum structure from a minimum of material.

Consideration is also being given to design a family of foam-reinforced plastic trusses for various roof spans. Each truss would be built in individual segments from a master mold. It is felt that the efforts made to date are only but first steps, indicating the possibilities in using foam-reinforced plastics combinations for military structures.—**End**

Ice cream dispenser

(*From page 80*)

point-of-purchase display to call attention to the product line.

Complete tooling necessary for production of this complex shape in steel was costed out at approximately $31,500. By comparison, the cost of molds for production of the vending unit in reinforced plastics came to less than $2000. And the unit cost of production in RP also proved to be less than it would have been in metal.

The ice cream container-dis-

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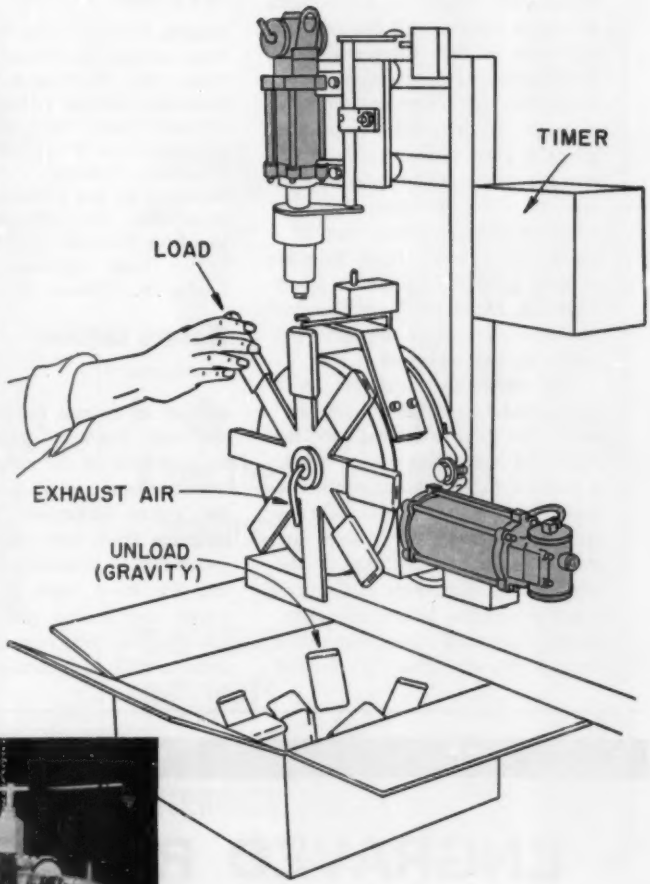

In this application a heated Slotting Tool is used, hence the Bellows BT-1 Timer to control the length of time the tool is in contact with the plastic part. The exhaust air from the Rotary Feed Table is used to give an assist in unloading the part.

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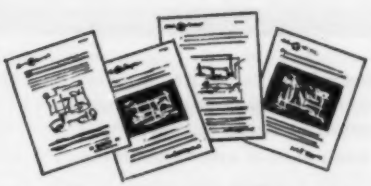

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DIVISION OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)

penser, manufactured by Space Structures Inc., Chanhassen, Minn., consists of inner and outer circular shells of RP with a rigid polyurethane foam lining. The shells, both of which have a wall thickness of about ⅛ in., are fabricated by a combination of hand lay-up using glass cloth reinforcement and gun sprayup of polyester resin and chopped glass fibers. A 12- to 15-mil gel coating is applied to all exposed shell surfaces, then the polyether-type urethane foam at a density of 2 lb./cu. ft. is foamed-in-place between the shells. Foam thickness measures 3 in. around the sides and top of the container and 4 in. at the bottom.

The completed structure is a 6-ft. insulated "cherry sundae," which is then mounted on the chassis of a half-ton pickup truck. A screw-type lifting mechanism to raise the insulated lid is held by an arm anchored to a steel arc embedded in the top rim of the container. In the center of the container is a Lazy Susan apparatus, which contains 10 dispensing chutes. Merchandise is loaded through the container's top, and it gradually comes down the chutes as bottom items are removed through access doors on both sides of the truck.

Credits: Polyester resin and urethane foam supplied by Freeman Chemical Corp., Port Washington, Wis.; reinforcement supplied by Owens-Corning Fiberglas Corp., New York, N. Y., and Pittsburgh Plate Glass Co., Fiber Glass Div., Pittsburgh, Pa.; gel coating furnished by The Glidden Co., Baltimore, Md. The polyurethane foam, also from Freeman, is dispensed by a mixing head applicator made by Prodco Inc., Chicago, Ill.—**End**

Safety ladder

(*From page 81*)

acts as an impact coating to protect the rovings; transmits the bearing load of the rungs to these same rovings; and adds strength to the entire structure. The polyurethane foam core eliminates the possibility of moisture penetration into the inner walls of rails and rungs, and it also provides hoop strength to the rungs, enabling them to resist a tendency to buckle from tension when they are stepped upon. Although results of mechanical strength tests had not been reported at the time of this writing, it is stated by the manufacturer that the ladder will support 2000 pounds. And the incorporation of 70 to 72% glass in areas where the parallel longitudinal glass fibers are used is said to provide tensile strengths falling within a 120,000 to 140,000 p.s.i. range.

American Allsafe markets both straight and extension ladders. Prices are $6.65/ft. for the straight ladders (total length from 8 to 16 ft.) and $6.95/ft. for extension ladders (total lengths from 20 to 32 ft.), about 4 or 5 times higher than prices for comparable wooden ladders. Weight of the new ladders, between 2 and 2¼ lb., is about the same as for wooden ladders.

Credits: Fabrication by Columbia Products Co., Columbia, S. C. Suppliers are: Celanese Plastics Co., Newark, N. J., polyester resin; Owens-Corning Fiberglas Corp., New York, N. Y., glass reinforcement; and General Latex & Chemical Corp., Cambridge, Mass., polyurethane foam chemicals.—**End**

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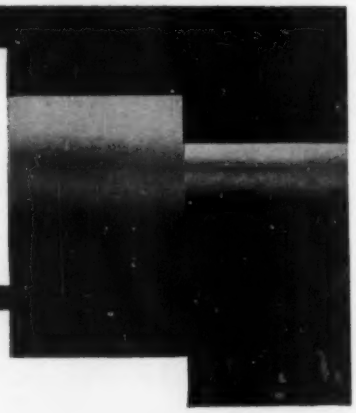

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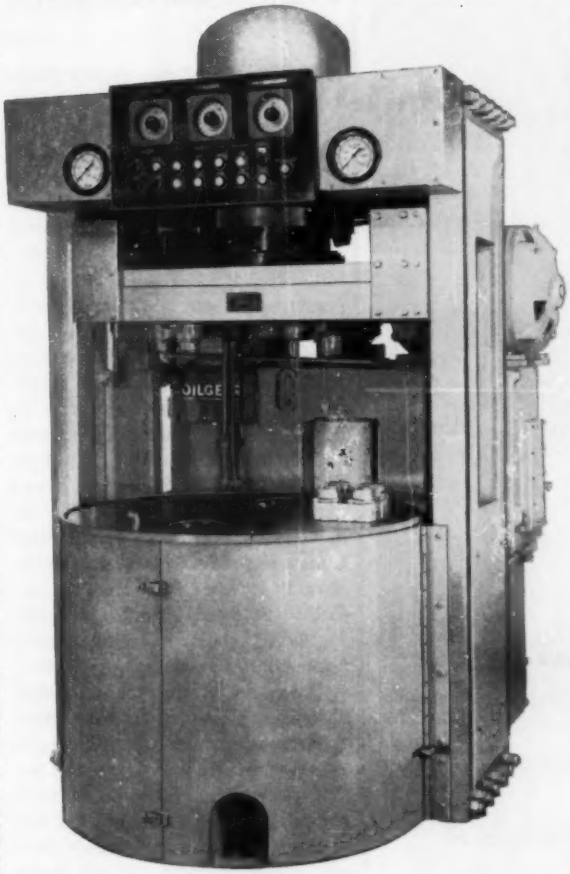

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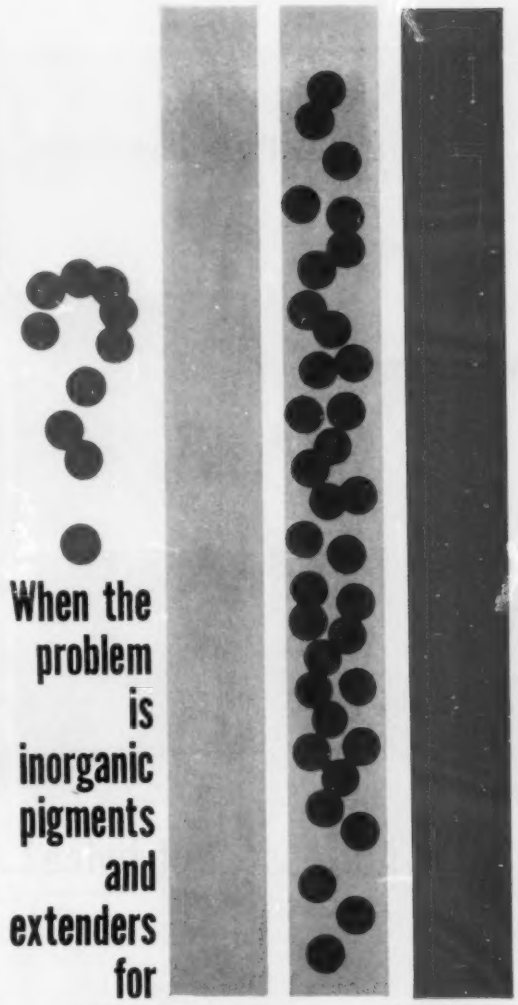

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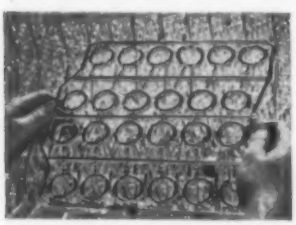

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STOKES

Printing plates

(*From pp. 86-87*)

mer plate than for a copper plate, but because of the uniform thickness and even printing qualities of the former may wind up with significant savings in press work costs.

In some instances, the Dycril plates can even compete with low-cost zinc plates, as in a one-color letterpress plate to be run on a patent-base. Because the photopolymer plate of this type is of the proper thickness for mounting on a patent base, the extra charges (50% over scale) that are incurred in bringing a zinc plate to the proper thickness are eliminated.

As one moves into more complex types of printing and plate making, the economics swing more toward the plastic. Take four-color printing. According to Primary Color Inc., New York, to make four-color plates by conventional photo-engraving techniques, much skilled—and costly—workmanship has to go into adjustments or color corrections in both the four negatives and the etched plates in order that the printed image reproduce the color values of the original art work. Since Dycril plates are not acid-etched but are an exact reproduction of the negative image, all such corrections can be made quickly and inexpensively when shooting the negative by taking advantage of modern masking, electronic color scanning, and the technique of dot etching on film.

Also holding promise for increased volume use of the plastics plates are some newer printing techniques which, if widely adopted, would represent sizable markets for the plastic's properties. Dry offset printing, in which the plastic plate produced in relief would replace the currently used flat, grease-treated, and water-quenched metal plates, is one such example. Wraparound letterpress printing is another. Presses of this type can use thin, flat Dycril plates curved around a press cylinder to match the quality and speed of the more expensive rigid, curved metal plates used on rotary letterpress printing presses.

With the ability thus to deliver top quality, with promise of lower plate costs, the Dycril plate seems destined to carve an important niche in printing.—**End**

Ultrasonic sealing

(*From pp. 95-102*)

of Mylar belts used for data display in the company's Readall Readout Instruments.

Endless Mylar belts containing numerals or letters are used to exhibit the information called for in the instrument display window.

Previous to the employment of an ultrasonic sealer, the belts were made in five separate steps. The Mylar strip used to form a continuous belt is 31½ in. long and $\frac{9}{32}$ in. wide.

Under the old method it was necessary to clean both ends of the unjoined tape of photographic emulsion for a distance of $\frac{1}{32}$ in. on each end to expose the plastic base and make fusion easier. An adhesive was spread on the ends which were clipped together and left to dry. The clip always formed a slight ridge.

Using an ultrasonic sealer, the bonding operation time was reduced by 75%; is now about 4 seconds. The adhesive, scraping, and the metal clip were eliminated. There is also no ridge or distortion in the bond.

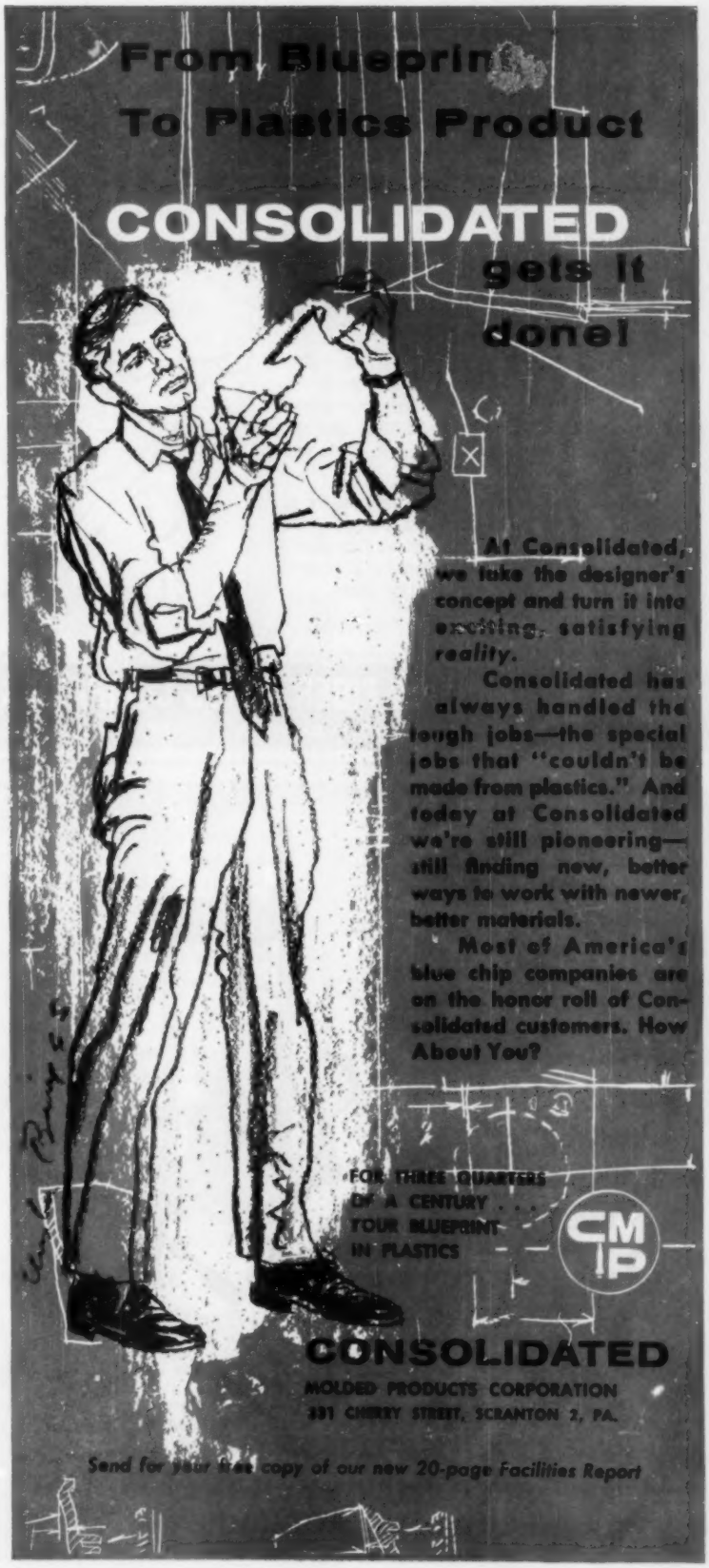
The above example also illustrates the strength of ultrasonic bonds. Prior to its use a test pull of 13 lb. would separate a tape. An ultrasonically sealed tape required a pull of 16 lb. before the spliced ends separated.

In addition to creating stronger bonds, the sealer also saves time, power, and material. This was proved at the Wildman-Jacquard Co., makers of knitting machinery.

Basic problem at Wildman-Jacquard involved the need for greater efficiency in sealing lengths of Mylar which form the perforated pattern cards or programming belts used to control knitting machines. The belts are $5\frac{11}{16}$ in. wide, vary in length from 14 in. to 40 feet.

Prior to the use of the sealer, four workers were employed in gluing the ends of the Mylar strips to produce continuous belts. It took 4 min. for the glue to set and properly react to the Mylar surface. Electric irons were clamped on the weld and the bond completed with heat and pressure. Time for one belt seam was 5½ minutes.

Use of ultrasonic equipment cut two-thirds off this time. The need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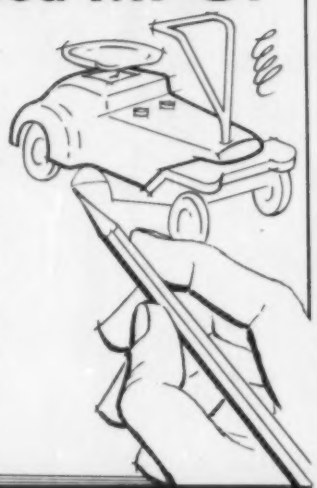

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for an adhesive, and electric irons, has been eliminated. Width of the old type seam was 0.25 inch. The new method makes an overlap less than $\frac{1}{32}$ in. wide. Now, one operator does the work of four, turning out an entire week's output of approximately 2400 belts.

The Mylar sheets are sealed quickly, noiselessly, and permanently, producing belts capable of service. Natural molecular welds are created without changing the properties of the Mylar.

Another feature of ultrasonic sealing lies in the basic principle underlying the welding itself. Because heat is generated internally in the plastic, and the faces of the film remain relatively cold, special molecularly oriented films do not fully lose their characteristics throughout the thickness of the weld—an occurrence typical of conventional techniques which fuse the material completely through. The advantage of the new device extends to heat-shrinkable films used in the tight packaging of foodstuffs. These films are not distorted and do not shrink at the weld area.

In ultrasonic welding, unlike dielectric sealing equipment, there are no high voltages present, nor is objectionable radio-frequency shielding needed. The tool can be touched without receiving shocks or burns. This makes it entirely safe for the user.

Also, the equipment is simple to operate and its use requires no extensive training. Operation may be taught in minutes. Initial settings for any specific gage of plastic film may be made in advance.

Ultrasonic sealers can weld practically all materials generally considered sealable by conventional equipment, as well as many others often considered unsealable.

A recent break-through in technique, soon to be introduced as an accessory of the Zephyr 300 sealer, makes possible the bonding of very thin films. Heretofore difficult to accomplish, this can now be done at high speeds.

Areas in which successful preliminary tests of the sealer have been made cover such diverse fields as packaging, textiles, computers and data handling equipment, food processing, home furnishings, fertilizers, chemicals, appliances, and radio and television.—**End**

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Iodine Value	5 Max.
Gardner Color	Less than 1
Gardner Viscosity @ 25°C	V Max. (8.8 poises)
Saponification No.	176 Max.
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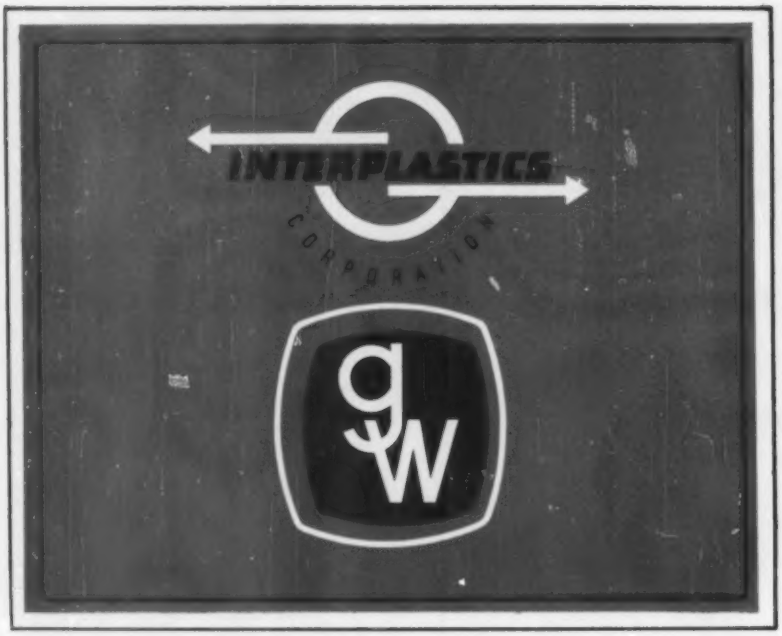

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Encapsulation

(*From pp. 103-111*)

ity of the mold release liquid. Solvent evaporation from the dip tank must be minimized by using a dip tank which can be sealed when idle and to which solvent can be periodically added to maintain the viscosity. Checking the specific gravity of solution is the simplest way to monitor the viscosity. The release agent and tank should be kept so that dirt will not be deposited on the molds.

Secondly, the dipping system must be set up to allow the molds to be withdrawn from the dip at a controlled rate. Usually a very slow withdrawal rate is needed to prevent the release agent from forming run streaks on the mold. The molds are removed slowly so that excess liquid drainage will return to the tank as fast or faster than the rate of mold withdrawal. The withdrawal rate must also be constant or horizontal streaks will form on the mold. The setup should be such that the base withdrawal rate can be varied as required. The principles involved are the same as those used to coat parts with varnish or any other coating which is applied by the dipping technique.

An example of a mold release dipping fixture for simultaneous coating of a large number of molds is shown in Fig. 6, p. 108.

Mold cleaning. Some flash or spillage is left on a mold after each use and will have to be removed before each cycle. If the mold is made of tool steel or if it has a hard surface and sufficient abrasion resistance, it is possible to use air-blast cleaning with a soft abrasive grit. The abrasive grit should only be harsh enough to remove flash; excessive abrasion will deteriorate the mold surface.

If the molds are too soft for this type of cleaning, hand cleaning will be required. If the entire mold has been coated with release agent, flash may be chipped from the mold by tapping with a leather mallet. The last resort is to scrape the mold. If scraping is done, do not use a sharp instrument. This will eventually result in scrapping the mold in high mold-maintenance costs, or in producing mold scratches which will be transferred

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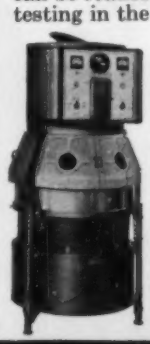

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to the finished part, thereby reducing its quality.

Grease and wax can be removed by brushing or by vapor degreasing. If the molds are metal, a strong solvent like methylene chloride can be used. If the molds are plastic, then a less potent cleaning solvent should be used to avoid ruining the molds. If the mold release is a thin film, no extensive cleaning may be necessary between cycles. This is the optimum situation and can sometimes be achieved by using low-viscosity, liquid release agents.

Finishing operations

Cutoff operations. Casting compounds are usually abrasive and hard on cutting tools. Although all are abrasive, the abrasiveness will depend to a large extent on the amount and type of filler used. Silica fillers are among the most abrasive; talc or calcium carbonate are less abrasive. The filler is a major factor if cutting is required.

Cutoff or sizing is done by sanding, grinding, milling, or sawing. Sanding is the worst method if the production volume is high, since most abrasive cloths or wheels tend to clog quickly. This results in a gradual reduction in regularity of the cut and in the finished surface quality. Holding the part by hand gives an uneven surface, and suitable holding fixtures for sanding are not always easy to make. Also, tool maintenance is very high; paper and wheels must be replaced frequently. In addition, variations in the sandpaper will produce varying results on the finished part. Multiple operations are often required to get a good finish, since rapid rough sanding chips edges of a cured resin part, and fine sanding is slow. Another disadvantage is that sanding is dusty, contributing to contamination and health hazards.

Milling, though not the best cutting method, is better than sanding, since the cutting action is more uniform. However, milling is also a slow and costly operation. The milled surface normally has a rough finish, particularly if deep cuts are used to speed the operation. If a smooth finish is required, a secondary fine sanding operation is often necessary.

Abrasive wheels **(To page 174)**

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SPECTROPHOTOFLUOROMETER. Illustrated folder describes instrument that identifies compounds through fluorescence properties . . . performs quantitative measurements . . . operates throughout visible and ultraviolet ranges, and when equipped with new accessory, extends range into the infrared. American Instrument Co., Inc. (101-H)

PAINT PUMP. Assorted illustrated technical bulletins describe paint pump, transfer pump, heavy material pumps, pump and container units, etc. Complete information, including specifications, other data. Binks Mfg. Co. (102-H)

DRILL PRESS FEEDS. Illustrated technical bulletin describes drill press feeds that feature rapid advance, controlled feed, and rapid return. Complete information, description, diagrams, other data. The Bellows Co. (103-H)

FLOW RATE TRANSMITTORS. Illustrated bulletin describes flow rate transmittors that offer linearity of scale and flow response, wide range of flow capacity (10:1 is standard); simplicity of construction, installation, operation and maintenance. Complete information, applications, features. Brooks Instrument Co., Inc., (104-H)

ROLL LEAF. Folder describes complete line of roll leaf, designed for the plastics industry. Covers standard colors, including imitation gold and silver, available from stock. Also, color matching. Admiral Coated Products, Inc. (105-H)

DRAWOUT MOTOR CONTROLLER. Illustrated brochure describes drawout motor controller—2,000 to 5,000 volts. So compact that two fit where one used to go. Complete description, information, advantages, features. Allis-Chalmers. (106-H)

SCALE MODELS. Illustrated book describes complete activities of firm that specializes in industrial scale models and prototypes. Includes industrial design, industrial engineering, aviation, electronics, architecture, etc. Complete information. Atkins & Merrill, Inc. (107-H)

FIBERGLASS PANELS. Illustrated folder covers fiberglass panels that let in soft, diffused light . . . reduce glare for workers . . . eliminate hazardous deep-shadow areas. Used for skylights, sidewalls, etc. Alsynite Div. of Reichhold Chemicals, Inc. (108-H)

COLOR MEASUREMENT. Illustrated brochure describes new technique of high-speed, fully-automatic color measurement. Designed to provide precise color signatures at rates as high as 30 samples per second. Complete description, general information, advantages, applications, etc. Allied Research Associates, Inc. (109-H)

ENGINEERING, MANUFACTURING. 10-page illustrated book describes complete activities of company that specializes in engineering creativeness and manufacturing capacity. Covers design, development and production of special machinery and component parts. American Technical Machinery Corp. (110-H)

MIXERS. Illustrated booklet covers complete line of mass and paste mixers. Also includes ribbon mixers. Complete descriptions, specifications, advantages and features. Paul O. Abbe Inc. (111-H)

GEL-TIME METER. Illustrated folder describes gel-time meter that stops automatically when gel-time is reached, records time, signals completion of test. Complete information, applications, specifications and shipping information. American Petrochemical Corp., Mol-Rez Div. (112-H)

METALLIC COLORS. Folder with sample swatches covers complete line of metallic colors available in cellulose acetate, polystyrene, butyrate and vinyl film. Available in gauges .0015 to .030, in rolls 20"-40" in width. Coating Products Inc. (113-H)

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are satisfactory when used properly. To minimize clogging, resin-bonded wheels should not be used. Also, fine grits should be avoided for the same reason. Air-cooling the wheel is also desirable. If any thermoplastics or low-softening-temperature materials are part of the item being cut, the wheel for this type operation is the Carborundum C24K6 wheel.[2]

A rotary saw is also an efficient cut-off fixture. Using the rotary cut-off saw, the part should be held stationary and the cutting edge moved into the part. This gives a very smooth finished surface.

When using either a cut-off saw or a milling fixture, diamond-tipped cutting edges are best. Carbide-tipped edges are next best. The frequency of use will dictate the cutter needed; if usage is high, diamond cutters are best despite their high initial cost. In addition to longer wear of the diamond cutter, the finished surface is usually smooth enough on the first cut so that no additional finishing operations are required.

Part marking. Marking or stamping can be applied using ink stamping, silk screening, or hot stamping. Stamped ink marking is the simplest marking method and a reliable one. Most suppliers have stamping equipment and inks which will withstand all the military tests for resistance to humidity, salt spray, etc.

An example of one of the ink stamping setups is shown in Fig. 7, p. 111. This is not entirely true of silk screening, since the marking is raised. The silk screen mark can be knocked off in handling and will not stand nearly as rigid environmental conditions as will stamping inks. Silk screening is also a slower, more costly operation than is the ink stamping.

One other point to be remembered in part marking is that mold release agent will leave a film on the finished part which will interfere with the adhesion of the marking ink to the part surface. If possible, it is wise to stamp on a machined surface; if not, the stamping area should be solvent-cleaned before stamping is begun.

If necessary, a clear lacquer can be applied over the dried stamping to protect it. In connection with

[2]Trademark, The Carborundum Co.

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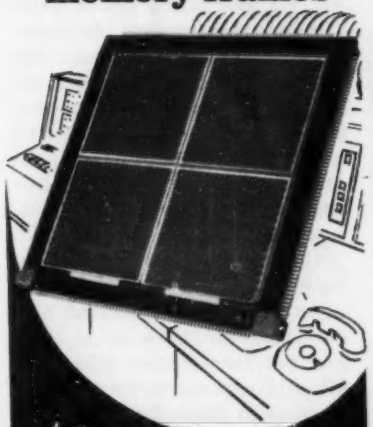

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the protection of markings on cut-off surfaces, the cut-off surface of a part always has a lighter color as well as a lower gloss than does the molded surface. This is especially true in a filled compound, mainly because of the exposure of filler particles.

Gloss and color can usually be restored by wiping the surface with a grease or oil. If the oil is applied after marking has been stamped onto the surface, then this grease or oil will also provide an additional protective coating for the stamped surface.

Other fixtures. There are many other fixtures which can be adapted to improve the efficiency and economy of an encapsulation operation. There is one particular type of fixture which has been found to be helpful in certain cases. In a lot of casting or potting operations, the part to be encapsulated with resin may need to be precoated to protect it before the actual casting or potting operation. An example is the application of a silicone-rubber coating to subminiature tubes or other components. Many times individual parts are coated separately. It is more efficient to set up a coating tank and a dipping fixture in which several parts are coated simultaneously. This also simplifies part handling, if the coating must be dried or cured, since the fixture can be used to transfer parts between operations.

Although the idea of having handling fixtures for multiple parts is logical, it is often overlooked. In analyzing the need for fixtures, the use of handling and transfer fixtures should be considered wherever possible.

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* Credits also to Minnesota Mining & Manufacturing Co., and Special Design Products Corp.—**End**

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Polyamides

(*From pp. 113-122*)

days at 140° C. the changes occurring in Filaments 1563 A and B were particularly interesting. The crystals in the oriented specimen have increased in size and number. All visible signs of crystallinity had disappeared in the quenched and drawn filament. Apparently, there were crystal nuclei in both filaments and, in one case, they grew during aging, in the other, they were unstable at the aging temperature.

In all three cases, the deterioration of tensile properties was severe (Table VII, p. 122). Tensile strength and elongation fell at the same rate for the three filaments, all reaching the same values after 8 days of aging.

The data just presented clearly indicate that physical treatment of nylon filaments makes it possible to improve their thermal stability. Nylon 66/610/pip-10 was improved the most by partial orientation and quenching in ice water during extrusion. On the other hand, partial orientation was the most beneficial treatment for Zytel 3606. Annealing at 200° C. considerably enhanced the stability of Zytel 3606, but at the same time resulted in extensive stiffening of the filament. For this reason, the piperazine polymer was not annealed. The chief drawback to most of these treatments, therefore, was the detrimental effect they had on the initial properties of the filaments. This effect was most apparent with annealed Zytel 3606 and drawn and quenched 66/610/pip-10; it was also evident, although to a much lesser degree, in drawn Zytel 3606. However, the properties of these treated filaments were considerably better than those of untreated filaments after 8 days of heat aging, which was the desired goal.

A high degree of internal ordering seems to be a general requirement for effective resistance to changes in mechanical properties during aging. Annealing at 200° C. induced this ordering in Zytel 3606. Less stable filaments, by comparison, were progressively less ordered. Drawing, which was also found to enhance the stability of Zytel 3606, is a process expected to increase the degree of ordering, although this was not confirmed by X-ray analysis. Molecular ordering was found to be characteristic of the most stable 66/610/pip-10 filaments. The quenched and drawn filament was the most stable and ordered; the "as extruded" filament was the least stable and ordered. The importance of molecular orientation can be regarded from this viewpoint; although it normally enhances the tendency for crystallization, the crystals would be expected to be more uniform. Therefore, embrittlement caused by crystallite imperfection would tend to be less severe in drawn filaments.

There is yet another reason for the importance of molecular orientation. It has been observed that drawing nylon film tends to elongate and then rupture spherulites (4). Although spherulites were not observed in these filaments, it is assumed that filament drawing can break large crystallites into smaller ones, and reduce the maximum size they could attain during aging.

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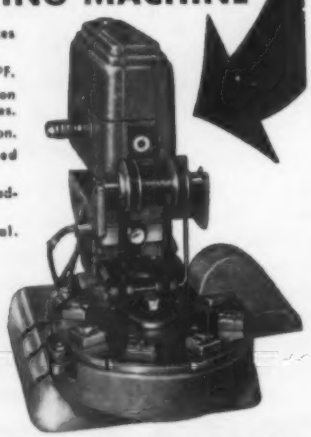

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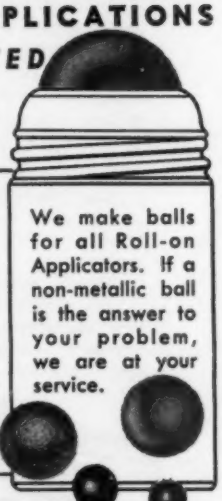

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tion, the disappearance of crystallites in drawn and quenched 66/610/pip-10 filaments was also significant. Their disappearance can be explained only by their initial size, which was probably small. Evidently these small crystallites were thermodynamically unstable at the aging temperature and, hence, disappeared. In this way, the amorphous character of the polymer was retained, which prevented embrittlement due to crystallinity, irrespective of the quality of the crystal structure. Quenching, although it produces small crystals, does not provide any stability, probably because it does not affect the degree of molecular ordering.

For some reason, quenching did not seem to help with Zytel 3606, as it did with nylon 66/610/pip-10. This may be partly because of the major differences between the two polyamides. For example, the latter polymer contains large amounts of piperazine, a secondary amine, on the main chain; thus, total molecular forces such as hydrogen bonding are reduced. This could result in a greater tendency for disordered crystal growth, unless applied forces make the growth orderly, or prevent it from taking place.

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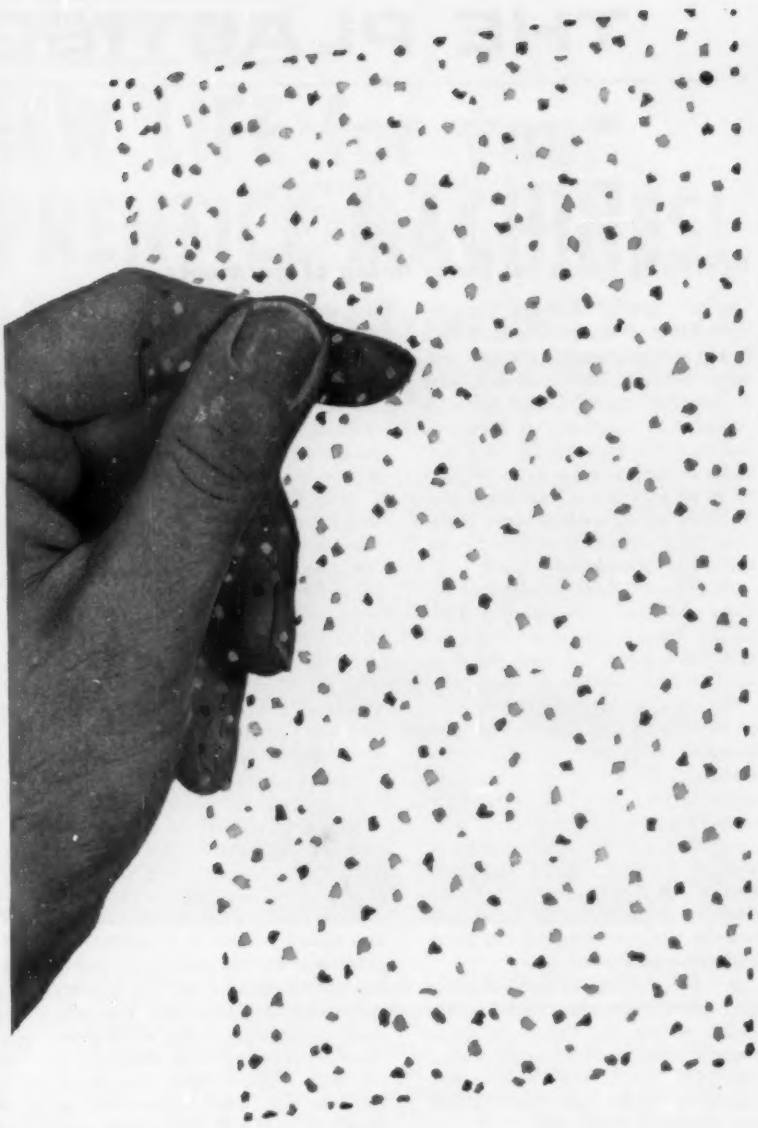

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By R. L. Van Boskirk

Section 2 *(Section 1 starts on p. 41)*

August 1961

Urethane foam for inner lining of garments

Use of polyester urethane foam for inner lining of garments is showing a steady growth. According to one company's estimate, the use of such foam as laminates to fabric for garments (outerwear, raincoats, windbreakers, jackets, vests, ski pants, etc.) is now at about 21 million linear yards (usually 45 to 60 in. wide) a year. Some 2 to 3 million yd. of urethane foam is also used for place mats especially for use with vinyl chloride table cloths.

One lb. of foam is required for about 3 yd. of cloth—since a 2-lb.-density foam weighs about 5 oz. per yd.—the amount of foam used is roughly 4 to 5 million pounds.

Polyester urethane is used almost exclusively for this application, even though it costs more than polyether urethane. The reason given by laminators is that polyether foam when peeled so thin is not uniform, contains holes, and does not dry-clean as well as polyester. This is said to be one of the few remaining uses for flexible polyester, since polyether foam is less expensive and has better cushioning properties.

Among the large-volume laminators are Reeves Bros., Garfield, N. J., which bought the Curon operation from Curtiss-Wright; Polydynamics, Fairlawn, N. J.; Precision Process, Lawrence, Mass.; and Textil Foam Inc., Palisades Park, N.J.

There are various other independent laminators but all of them are comparatively small-volume. In addition to all these, there are various textile or garment firms who buy polyester foam from companies like Scott Paper or Nopco Chemical Co. and do their own laminating. The industry is already overcrowded, although it is comparatively new.

A visit to the Polydynamics plant by this reporter unveiled some interesting aspects of this industry. There are purchasers of foam in roll or "bun" form. Company officials state that its peeling operation from the bun is particularly efficient in an area that has been difficult to master because they can then control quality for the foam used in laminating. Not only can it peel in wider widths (up to 82 in.) but also manages to lower the waste content under the 30 to 35% generally expected. The waste is the outer skin of the bun, a tough resilient material that must be peeled before the foam is suitable for laminating. Sometimes it is sold as a packaging material like excelsior, but lots of it is sheer waste.

After the film has been laminated to a fabric, it is run at 60 to 100 yd./min. through a steam oven at about 500° F., and then into a dry box for curing for about 5 minutes. A special silicone-oil emulsion is used after, rather than before, lamination to prevent future delamination. This is to give it a superior water-repellent quality in contrast to non-permanent wax-base repellents used by many other processors. The adhesive used in laminating must be dry-cleanable and flexible to prevent boardiness.

This urethane-type lining is used primarily to replace wool inner-linings. It has equivalent warmth properties, dry-cleans easily, can be washed, gives warmth without weight, and doesn't wrinkle. It is particularly acceptable for use with nylon fabric for men's outerwear and also in overcoats—also as a shoe liner. One garment maker is producing an 11-piece ensemble, ranging from shorts to a hat, with urethane liners. No one is sure just how much volume can be eventually absorbed by the inner liner market. Up to now at least, the market and its potential is great enough to create severe competition.

Pearlescent polypropylene

Polypropylene in pearlescent colors has been added by Enjay Chemical Co. to its Escon polypropylene line. In combination with the molded-in integral hinge design concept, the new pearlescent-colored polypropylenes are said to be especially suitable for fabrication of cosmetic compacts and closures, and similar containers.

Standards for housewares

The Plastic Housewares Institute, Box 6015, Akron, Ohio, has drawn up a plan with material suppliers and manufacturers whereby it is agreed that there will be no charge to any manufacturer for the evaluation of his plastics products. The cost will be assumed by the volunteer group of material suppliers. The Institute is planning a series of exhibitions to call attention to standards and quality in plastics housewares, the first of which will be at the 11th National Chemical Exhibition in Chicago, Ill., Sept. 5 to 8. Among the exhibits will be Lionel's new plastics engineering sets which will demonstrate how plastics are made and carry the Institute's label of approval.

Housewares manufacturers have been talking for years about the sloppy, poorly designed items made by their competitors (it seems it is always the competitor who comes up with shoddy material). Here is a chance for the industry to get together and do its own policing and house cleaning. The Institute hopes it will receive financial, as well as spiritual, support from members of the plastic's industry who furnish raw materials and are interested in maintaining a high quality standard for products made with their materials.

Reichhold's new phenolics and oxo alcohol

Two new phenolic resins developed to withstand exposure to high temperatures encountered by missiles and space vehicles have been announced by Reichhold Chemicals Inc., White Plains, N. Y. One, designated Plyophen 23-017, is a phenolic silicone resin which is superior to the straight phenolic resins and to the epoxy modified resins for exposure to high temperatures for fairly long periods of time. The other, Plyophen 23-057, is a polyamide-modified phenolic resin, which was developed especially to withstand ablation and burn-through resistance when the material is exposed for short periods of time to temperatures in excess of 6000° F.. Reichhold is now producing four phenolic and modified phenolic resins for the preparation of products that withstand high temperatures.

Reichhold has also announced it had contracted with Air Products Inc. for the principal output of a new plant to produce oxo alcohol, to be constructed by Tidewater Oil Co., next to its Delaware refinery. Reichhold stated that its increased demand for oxo alcohol had been brought about by a 100% rise in the manu-

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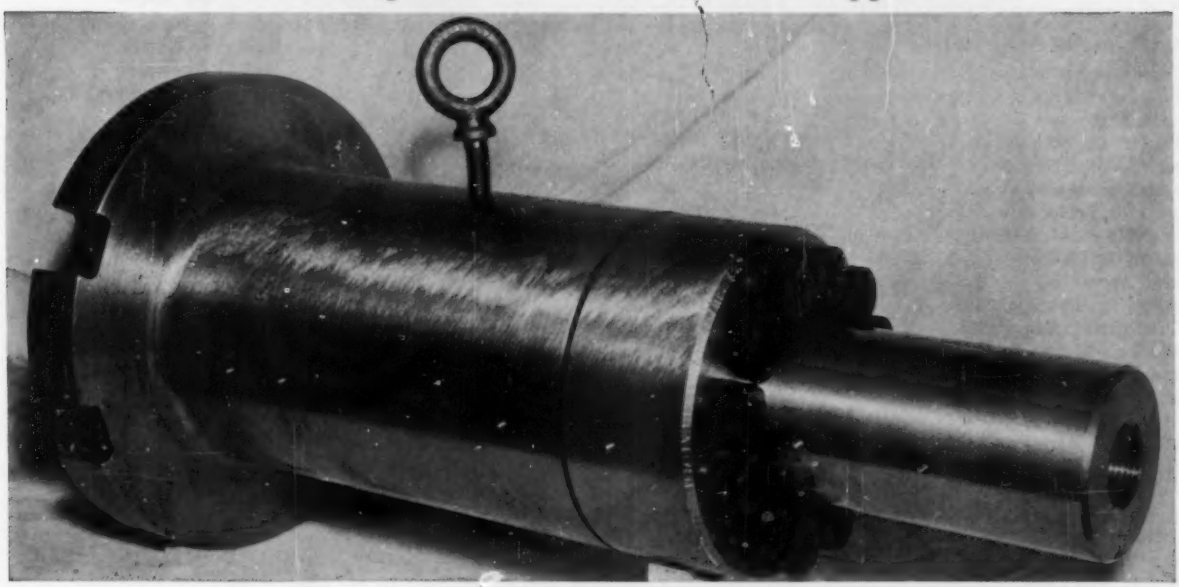

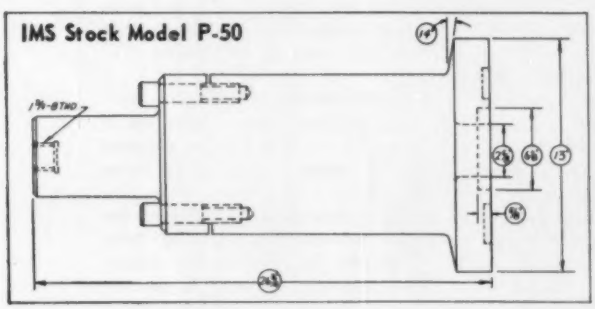

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THE PLASTISCOPE

(From page 173)

facture of plasticizers by its Deecy Products Division.

Reichhold also plans to install new equipment for the manufacture of plasticizers at its Detroit plant and some of its plants located in California and on the East Coast, to make use of the new plant's production.

Plastic-metal combination

A new material that joins metal mesh with plastic in such a manner as to interlock the two materials without adhesives has been announced by The Sparlite Corp., New York, N. Y. The material, designated Sparlite, presents a dual-color cellular appearance (*e.g.*, gold metal mesh on black plastic), in which both the metal and plastic appear on the same surface. By varying the plastic from opaque to transparent, many colors, textures, and effects are possible. In addition, the metal mesh is available from a fine micromesh up to 3-in. openings.

According to The Sparlite Corp., a preliminary marketing survey indicates interest in such fields as architecture, decoration, lighting, automotive, boat, and luggage. Sparlite can be made in flat sheet form, in molded, compound-curve panels, as well as complete containers, according to a company spokesman.

Non-burning urethane foam

Development of a new non-burning flexible urethane foam, said to exceed the requirements set forth by Underwriters' Laboratories, has been announced by Plastomer Corp., Detroit, Mich. Tests conducted by Plastomer Corp. reportedly show that the new foam product is not only non-burning, but that flammable material, such as paper, is self-extinguishing when bonded to it. UL regulations specify that foam insulation and gasketing used in air conditioning and allied products be self-extinguishing.

Corrosion-resistant reinforced plastics

Three new sizes of fibrous glass-reinforced polyester channel stock have been added by The Glastic Corp. to its line of corrosion-resistant shapes for structural and electrical insulating applications. This brings to 13 the number of types available.

The channel stock is resistant to most corrosive salts, non-oxidizing acids, weak alkalies, alcohols, and formaldehyde. It is engineered for use at temperatures up to 130° C., is said to meet NEMA GPO-1 specifications and to have UL-recognized flame retardance. It also features the strength as well as low moisture absorption that are typical of fibrous glass reinforced polyester.

The channels can be used as is or cut to meet specific job requirements. Applications include duct hoods, corner supports, motor mounts, component bases, insulating offsets, bus supports, cable supports, etc.

Third new plant for Kordite

Tyler, Texas, has been selected as the site of a third major plant addition for The Kordite Co., Div. of National Distillers and Chemical Corp. Kordite established new plants at Jacksonville, Ill. in 1957 and Woodland, Calif. in 1959. Its executive offices and largest plant facilities are in Macedon, N. Y. Initial output of the new plant will be devoted to polyethylene films for packaging.

The company expects a 25% sales increase in 1961, and double 1960 sales figures by 1963. In 1961, 20% of Kordite sales have been in products unmarketed before 1960; 40% of the first-quarter 1961 sales were in plastic products developed since 1958.

This year, the plastics firm will invest more than $3 million on a new Research and Technical Services Center in Macedon. With the completion of these facilities, the company's research staff will be increased.

In foreign marketing and distribution of plastic packaging products, Kordite foresees a virtual explosion of growth in the next 10 years. The firm recently formed a jointly-owned international company to manufacture, market, and distribute polyolefin plastic products throughout the world, excepting the United States and Canada. The company, known as Shorko Ltd., with headquarters in London, is jointly owned by the Royal Dutch Shell Co. of The Hague and London and Kordite.

The potential for the new company is reflected in the fact that capacity and consumption of polyolefin plastics at the end of 1960 was approximately 2½ to 3 billion lb. throughout the world. It is anticipated that this figure will increase from 40 to 60% by 1963. The United States accounts for more than half of the 1960 figure, but will probably account for less than 50% of the world production in 1963, say Kordite officials.

An index of the growth of the transparent flexible packaging film market abroad is provided by the fact that the approximately 200 supermarkets in Western Europe in 1943 have grown to 20,000 in the same area in 1960. At the present time, reports indicate that a new supermarket is opening every day in West Germany.

Lasco organizes chemical division

Organization of a Chemical Div. to produce intermediates used in plastics, paints, and chemicals was announced by Lasco Industries, Montebello, Calif. producer of fibrous glass building panels and plastic pipe. Henry C. Nelson, for 17 years with General Electric Co., most recently as general manager of the company's West Coast Chemical Materials Dept., has been named manager of the new Lasco enterprise.

Roderick O. Lynch, president of Lasco, said the division will carry on the activities of Borane Chemical Corp., a subsidiary organized last Fall but since dissolved.

The Montebello company started out as a maker of reinforced polyester panels as patio covers, in fencing, and in office partitioning. In 1957, Lasco got into the plastic pipe field with one extruder and sales for the year of $157,000. Today it has five extruders working around the clock and sales are 10 times 1957's start. Twice in six months the company has increased its capacity 25 percent. Lasco reported earnings in 1960 of 20¢ a share against 18¢ the previous year, but there was considerable expense in moving into the new plant and some loss of production time. First quarter 1961 sales were up 33 percent.

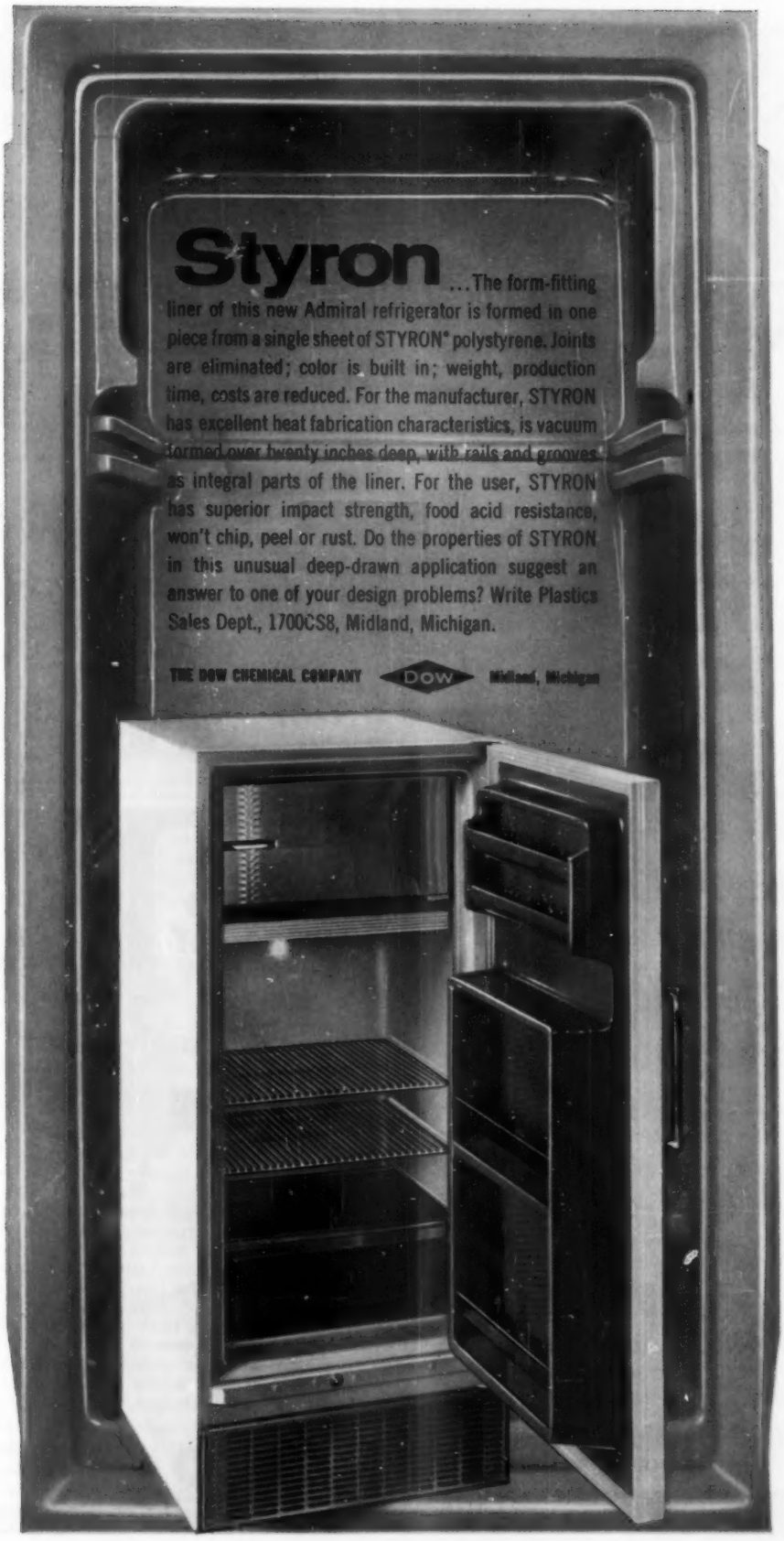
Polycarbonate shapes

Lexan rod and slab in sizes up to 72- by 12- by 3-in. can be obtained from Westlake Plastics Co., Lenni Mills, Pa.

Zelux, the company's tradename for Lexan rod and slab, which has been normalized by its patented Liquo-Temp annealing process, is machinable by conventional machining methods. It can be cut, drilled, tapped, milled, or otherwise machined to close dimensionally stable tolerances. Primary application area is for prototype and small run parts.

Non-flammable solvent-type coatings

A solvent-type coating, said to be nonflammable in liquid form, has been announced by Columbia Technical Corp., Woodside, N. Y. Called Humi-Seal Type 1B20, it is a single-component, air-drying, solderable, acrylic-base coating. It is said to eliminate the shipping, storage, and (To page 183)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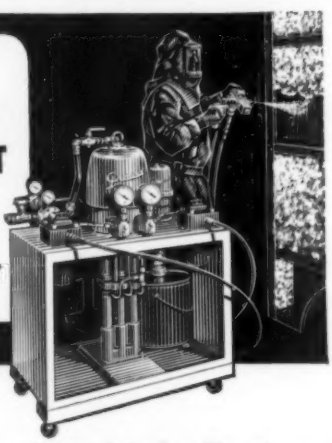

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THE PLASTISCOPE

(*From page 180*)

application problems faced by users of solvent-type coatings, which are now classified as "red-label" materials. To heavy users, such as the electronics industry, who use solvent-type coatings for printed circuits, data cards, and components, HumiSeal Type 1B20 represents a material that should effect considerable savings.

Foil decorators conference

The 3rd Ornamin Conference, sponsored by Ornapress A. G., pioneers in the development and manufacture of overlay foils for molded-in decorating techniques, and held in Zurich, Switzerland, June 12-15, pointed to the growing importance of the foils as a decorating media for the plastics industry. As hosted by S. Hallauer of Ornapress in Zurich, the parent company, the conference included reports from various international licensees on the use of the foils not only in the well-known area of melamine dinnerware, but also in the newer markets for decorated industrial parts (*e.g.*, knobs, dials, buttons, gifts, tile, clock faces, signs, closures, and escutcheons—in melamine, urea, or phenolic). It was predicted that the latter area would feel the same impact from use of the foils as quality melamine dinnerware did earlier (some 80% of this dinnerware is currently decorated by overlay foils). Reasons for the optimism: costs are lower as compared to such finishing operations as hot-stamping, engraving, or "wipe-ins," letters, figures, or designs can be altered simply by changing the foil—while retaining the same mold; and alternate color schemes are possible at no extra cost.

The conference also saw the introduction of Poly-Ornamin, a reverse-printed overlay foil designed for decorating such polyester-glass products as trays, display signs, wall panels, luggage, traffic signs, etc. (All of these developments will be covered in a future issue).

U. S. Coast Guard-approved lifeboats installed

Installation of U. S. Coast Guard-approved, fire-retardant, fibrous glass-laminated lifeboats on the *S. S. Mormaclake*, has been announced by the manufacturer, Lunn Laminates Inc.

The prototype, a 30-ft., 78-person capacity, hand-propelled lifeboat, weighing 5350 lb., was rigorously tested under CG supervision prior to approval, according to Lunn. In addition to all standard tests required of steel or aluminum lifeboats, such as freeboard, stability, seating capacity, propulsion, and towing, the reinforced plastics lifeboat prototype was subjected to a shock test, thwart test, drop test, slam test, and a buoyancy test. After these strenuous tests, the contact-molded lifeboat showed very little damage and was still serviceable.

The *S. S. Mormaclake* is the fifth in a new series of speedy cargo-passenger liners being built for Moore-McCormack Lines.

Reinforced plastics pressure pipe

A standard line of corrosion-proof Duracor reinforced plastics pressure pipe capable of withstanding pressures up to 100 p.s.i. at temperatures as high as 250° F. is now available from The Ceilcote Co., Cleveland, Ohio. The pipe is available in 10- and 20-ft. lengths and is furnished in fibrous glass-mat-and-cloth construction. Wall thickness ranges from ¼- to ⅝ in., depending on pressure and temperature requirements. The pipe is said to be suitable for either above-ground or underground installation and may be installed with a stamped sand backfill, concrete cradle, or completely encased in concrete.

For plasticizer manufacture

Two products for use in the manufacture of primary plasticizers, introduced by Continental Oil Co., Houston, Texas, are said to improve certain properties of plasticizers made from them. The two materials are Alfol 610, which will be priced at 18¢/lb., and Alfol 810, 19¢ per pound.

Alfol 610 is a three-component blend of 1-hexanol, 1-octanol, and 1-decanol. Alfol 810 is a two-component blend of 1-octanol and 1-decanol. Phthalate esters made from these compositions are said to have excellent properties, particularly with regard to plasticizing efficiency, low-temperature properties, and low volatility. In these respects, the Alfol-based phthalates are superior to DOP and DIOP, according to the company.

Vinyl-acrylic dispersion

A self-crosslinking resin latex for use as a binder has been developed by National Starch and Chemical Corp's. Resin Div. Introduced as X-link 2833, the new vinyl-acrylic copolymer dispersion is capable of crosslinking without the addition of thermosetting resins to form strong and flexible films said to have exceptional resistance to water, solvents, and creep. According to the company, use of the latex has been found to eliminate problems of stability, odor, compatibility, and high curing temperatures usually associated with combinations of thermosetting and thermoplastic resins. Application areas for X-Link 2833 include non-woven fabrics, wallpaper coverings, paper saturation, adhesives, awning coatings, and textile finishes. Adhesion of the latex to a variety of substrates suggests its use as a tie coat for organosols.

Nylon bristles with built-in fluoride

A process of combining a fluoride compound with polymers used in making nylon toothbrushes has been announced by National Plastic Products Co., Odenton, Md. This development, coupled with the recent recognition of fluoride as a cavity-reducing chemical used in oral hygiene, marks a major improvement in the care of teeth and gums, according to National.

Lower fusion temperatures for plastisols

A new resin for making plastisols with unusually low fusion temperatures has been introduced by B. F. Goodrich Chemical Co., Cleveland, Ohio. Fusion temperature for plastisols based on the new resin, Geon 135, is said to be 300° F., compared to 350° for other plastisols.

Geon 135 is a copolymer, thus less plasticizer is needed to obtain equivalent hardness than for compounds based on conventional polyvinyl chloride resins. The new resin also is said to lower Brookfield viscosity and to improve viscosity aging. It is suitable for rotational molding, slush molding, dip molding, stencil printing on vinyl sheeting, vinyl foam, and as a tie-coat for lamination of film to fabric. Geon 135 is priced at 24¢/lb. in truckload quantities.

RP sandwich panels in construction

A new, colorful, and translucent building product, consisting of glass-reinforced polyester skins and a honeycomb core, has been used in the construction of a building housing a laundromat in Manitou Beach, Mich. The new product is known as Plastifiber. The building was constructed by Crystal Aluminum Products Inc., Toledo, Ohio.

The panels, supported by aluminum frames, provide the roof and two load-bearing front walls of the L-shaped structure.

The panels, manufactured in 3- by 16- and 4- by 16-ft. sizes, are fabri-

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CHEMICAL MATERIALS CATALOG, Page 179

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THE PLASTISCOPE

(*From page 183*)

cated by Plastifiber & Chemicals Co., Crystal Lake, Ill. The mat used in the process is a product of Owens-Corning Fiberglas Corp. The polyester resin is manufactured by The Glidden Co.

Flowable amide for slip and anti-block

A new fatty amide, Kemstrene Su, has been announced by HumKo Products, Chemical Div., Clifton, N. J. According to HumKo, this new amide is a dry, free-flowing powder which will provide improved slip and anti-block properties to polyethylene and polypropylene films.

One-shot rigid foam

A new one-shot, rigid, fire-retardant polyurethane, Hetrofoam 250, has been introduced by Durez Plastics Div., Hooker Chemical Corp. Foam is created by the simple reaction of a polyol and a polyisocyanate. In field tests with sandwich panels, the foam reportedly has demonstrated rapid and uniform rise (1 ft./5 sec.) to heights exceeding 8 feet. Excellent skin-bonding characteristics to a variety of surfaces, rapid cure, and uniform densities are obtainable even under reduced mold pressures.

The foam, highly fire-retardant through inclusion of chlorine-rich Het Acid, is said to have good dimensional and heat stability, low water absorption, and low moisture permeability.

Vinyl stabilizers

Two new single-package liquid vinyl stabilizers have been introduced by the Metasap Div. of Nopco Chemical Co., Newark, N. J. Designated Metasap ABC-51 and -52, the new products are cadmium-barium-zinc liquids for stabilization of calendering, molding, and extruding grades of polyvinyl chloride. They are said to provide optimum balance between initial color and long-term stability, improved light stability, as well as sulfur-stain resistance.

Melamine in furniture

A new type of solid panel and dimension stock for the furniture and allied industries, tradenamed Corex, has been introduced by the C. F. Church Div. of American-Standard. According to the company, the new material is produced by fusing melamine resins and wood flour impregnated with thermosetting plastic resins into solid, homogeneous plastic-surfaced panels. There is no glue line or adhesive-bonded surface. Because of the material's solid construction and low

moisture absorption, it is said to have a high degree of dimensional stability.

The Corex panels are made in woodgrain and marble surface patterns, and in varying degrees of surface gloss.

High-strength film adhesive

A new thermosetting film for metal-to-metal bonding and metal honeycomb sandwich construction is now available from Adhesives, Coatings, and Sealers Div., Minnesota Mining and Mfg. Co. The new film adhesive, designated Scotchweld Brand AF-110, can be cured under pressures of 10 to 25 p.s.i., the pressure necessary to provide contact between the parts being bonded and to keep the parts properly aligned. This feature eliminates the need for jigs and fixtures for pressure application, and makes the adhesive suitable for production bonding operations. Normally, film adhesives require an optimum curing pressure of from 50 to 150 p.s.i.

Fibrous glass panel withstands stress

A glass-reinforced acrylic-polyester panel with a higher percentage of acrylic than is contained in conventional panels, has been introduced by the Barclite Corp. of America, affiliate of Barclay Mfg. Co. Inc. Called XR1000, the panel is said to withstand erosion more than five times better than standard panels, with better retention of light transmission, as well as color properties.

Dow extends polyolefins line

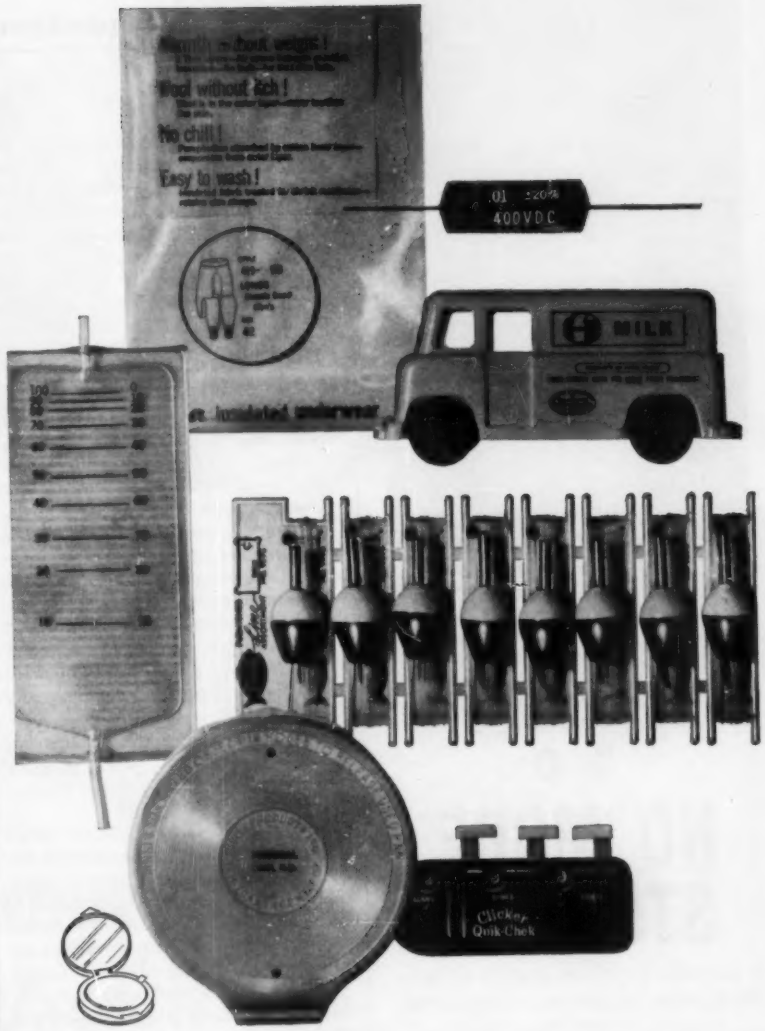
A series of eight linear polyolefin resins for injection molding, blow molding, and extrusion has been introduced by The Dow Chemical Co., Midland, Mich.

High-density polyethylene R600, R800, and R810 are designed for injection molding and extrusion applications that require materials with good flow properties. High-density PE R211 and R401 are resins designed specifically for blow-molded containers. PE R200, R210, and R300 are general-purpose, high-density polyethylenes suited for both blow molding and extrusion applications.

R200, R210, and R211 are priced at 35¢/lb. for natural in truckload quantities. The other five formulations are priced at 32¢ per pound.

Magnetized thermosets

A thermosetting plastic which can be spot magnetized to provide practically any desired pattern within a molded part has been announced by Mesa Plastics Co., Los Angeles, Calif. The compound, which has been tested beyond 400° F., includes non-conductive



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THE PLASTISCOPE

(*From page 185*)

ferrite powder fillers capable of retaining either temporary or permanent magnetic charge. Polarity of the magnetic field set up may be oriented in any chosen direction. Applications include memory drums, DC motors, relays, and transducers. The material is said to have excellent moldability. Limited quantities are available for field testing.

Bottle making on West Coast

Olympic Plastics Co., Los Angeles, Calif., has started construction of a 40,000-ft. building designed specifically for production of blow-molded bottles in both conventional and linear polyethylene. In addition to a complete line of standard plastic bottles, Olympic offers design facilities for custom-molded shapes. The company also offers extensive decorating services. It has three- and four-color offset printing presses in addition to silk screening and hot stamping, and is presently installing the new Dennison Therimage Labeling equipment.

Fibrous glass chopped strand mat

Claimed to wet out three to five times faster than other products now in the field, Garanmat, a fibrous glass chopped strand mat, has been introduced by Johns-Manville. The product is made of continuous-filament fibrous glass roving to which Garan binder has been applied. The roving is chopped into lengths of about 2 in., formed into a mat with random pattern, and bonded with resins.

Garanmat is available in weights of 1¼, 1½, 2, and 3 oz./sq. ft., in widths up to 76 inches. Shortly, it will be available also in ¾-oz. and 1-oz. weights.

Green PE film

A new green polyethylene film, made by Canton Containers Co., Canton, Ohio, is being used by farmers as the latest refinement in horizontal silo covers. The 7-mil-thick film is said to be a great improvement over paper, sawdust, wheat, oats, and even black pigmented PE film as a protective cover for trench and bunker silos. Used in this way, it helps provide better silage storage conditions at a fraction of the cost of upright silos. The covers can be custom made to fit virtually any trench or bunker size. The covers use green pigmentation to help ward off harmful ultraviolet sun rays. The covers' thickness provides strength for serviceability and long life (up to three years in normal use). Canton also uses the green 7-mil polyethylene film in ice rink liners and swimming pool covers.

New companies

Consolidated Bases Inc., Belleville, N. J., has recently been organized to manufacture molded bases for plastic and die casting molds. **P. Edward Rycyk** is president.

Autronic Plastics Inc., 760 Eagle Ave., Bronx, N. Y., has been formed as a molder and extruder of housewares and toys by **Harold Osrow, Leonard Osrow,** and **Harold Lax.**

Win-West Plastics Inc., 759 N. Milwaukee Ave., Libertyville, Ill., is a new company organized to mold small precision thermoplastic parts. **Emil Westergaard** is president; **Harold Winzeler** is vice-president.

Expansion

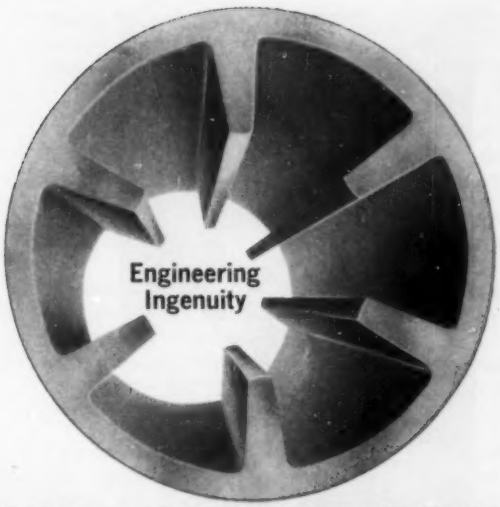
Union Carbide Chemicals Co. is adding a unit for the production of phthalic anhydride to its plant at Institute, W. Va. The new unit will employ the fluid-bed process and will have a capacity of 50 million lb. per year. It is expected to be in full operation in the latter part of 1962.

The General Tire & Rubber Co., Textileather Div., is constructing a $400,000, two-story office building at the company's plant in Toledo, Ohio. Floors will be covered with General Tire's Bolta vinyl tile, and Textileather's vinyl products will be used on doors, partitions, and office furniture upholstery. Completion is scheduled for sometime in December.

Rogers Corp. has constructed an addition to its Manchester, Conn. plant, which will double capacity for manufacture of diallyl phthalate molding compounds. The facilities are expected to be on stream this month.

Vogt Manufacturing Corp. has acquired all of the equipment used by **M-R Plastics Research Inc.** from the Rathbun Investment Fund. The equipment has been moved to the **Leaming Industries** plant, in Canandaigua, N. Y., where a **Rathbun Molding Div.** of Leaming has been established. Leaming is a subsidiary of Vogt. **Merle Rathbun,** who formerly headed M-R Plastics and **Rathbun Molding Corp.,** has joined the new division, which will do compression, transfer, and injection custom molding.

California Chemical Co., subsidiary of **Standard Oil** **(To page 189)**



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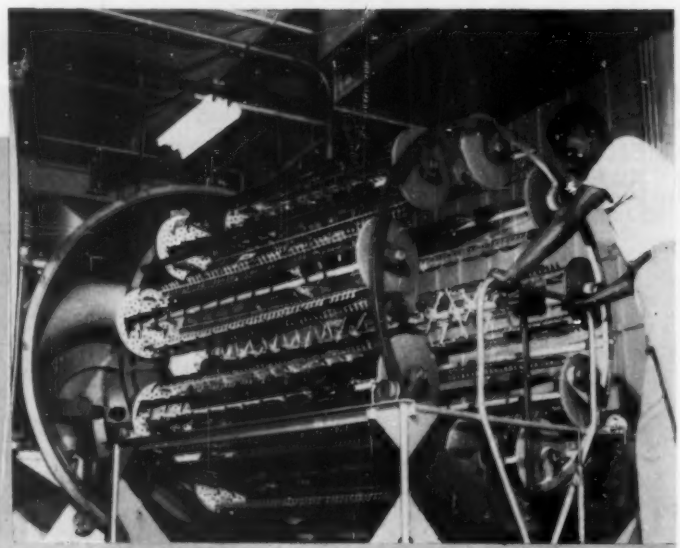

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THE PLASTISCOPE

(*From page 186*)

Co. of Calif., announced plans for the construction of a new plant at Hull, England, to produce 35 million lb./yr. of phthalic anhydride. The plant is scheduled for completion during the second half of 1962.

Industrial Plastic Molders Inc., Hialeah, Fla., a new affiliate of **Russell, Burdsall and Ward Bolt & Nut Co.,** has expanded facilities for injection molding and pigmenting of thermoplastic parts.

Cary Chemicals Inc., producer of PVC polymers, copolymers and compounds, has approved a $14-million investment in new production facilities, including the construction of a new polymer plant designed to produce 150 million lb./year of polyvinyl chloride. Present facilities include a 50 million lb./yr. polymer plant at Flemington, N. J., and a 36 million lb./yr. compound plant at East Brunswick, N. J. A subsidiary, **Great Bay Chemicals & Plastics Inc.,** has calendering and finishing facilities at East Brunswick and is now building 70,000 sq. ft. of manufacturing space to include an additional calendering line.

Raritan Plastics Corp., custom extruder, has moved from Paterson, N. J. to its newly completed 25,000-sq.-ft. plant on a 20-acre tract in Oakland, N. J. Production facilities have been doubled.

Plastomer Corp., Detroit, Mich. manufacturer of urethane foam products, has doubled its production capacity and installed new die cutting equipment. Among the company's new developments are a new foam sponge, a wax-impregnated disk for floor finishers, and a sound deadener kit for outboard motors.

Lock Joint Pipe Co. has acquired **Oscar Davis Co. Inc.,** Paterson, N. J. fabricator of rigid PVC valves and fittings, which will be operated as a wholly-owned subsidiary. Present management, headed by **Oscar Davis,** will be retained. Lock Joint recently acquired **Corroplast Inc.,** an extruder of PVC pipe, bars, and shapes.

The Borden Chemical Co. has announced plans to construct two major chemical plants in Geismar, La., at a cost of approximately $15 million. To be included are a methanol plant with annual capacity of 25 million gal., and a vinyl acetate monomer plant with capacity of 50 million lb. per year. Both operations will be located adjacent to **Monochem Inc.,** a company jointly owned by Borden and **U. S. Rubber Co.,** which will supply the Borden-owned methanol and vinyl acetate facilities with all of the needed raw materials, except acetic acid.

The Fluorocarbon Co., Anaheim, Calif., has established a subsidiary, **Fluorocarbon of Arizona Inc.,** in Phoenix, as a fabricator of Teflon and Kel-F products.

Schenectady Varnish Co. Inc. has announced plans to construct a full-scale phenol plant at the company's 56-acre waterfront site at Rotterdam Junction, N. Y. The new plant, which will mark the 55-yr.-old firm's entry into basic raw material production, is scheduled to come on stream in the early part of 1962.

Technical Systems Inc., Culver City, Calif., has purchased all assets of **Mason Mold Corp.,** Covina, Calif. Mason Mold's principal product is a precision epoxy molding system for potting small components in production quantities.

Du Pont Co. (United Kingdom) Ltd. has announced plans to build a multi-million dollar plant for the manufacture of isocyanates at Maydown, near Londonderry, Northern Ireland. The plant is expected to be in operation late in 1963. The new facility will supply Hylene organic isocyanates, used in making both rigid and flexible urethane foams, for markets in the United Kingdom and for export to other countries comprising the Free Trade Area.

Harte & Co. Inc., producer of vinyl film and sheeting, and polyethylene, plans to erect a new 44,000-sq.-ft. research center adjacent to the firm's existing plants in Brooklyn, N. Y. The building will primarily house Harte's R & D laboratories, but will also include a certain amount of space for plant operations and administrative offices. Completion is expected by Spring 1962.

Abbott Plastic Machine Corp., producers of skin packaging and pressure forming equipment, has moved its main plant and offices to 2718-26 Broadway, Chicago, Ill. The new facilities include 14,000 sq. ft. of shop area, 1000 sq. ft. of office space, and a large showroom.

Tronomatic Corp., New York, N. Y., manufacturer of expandable styrene molding machinery, has acquired **Dynatech Products Inc.,** together with

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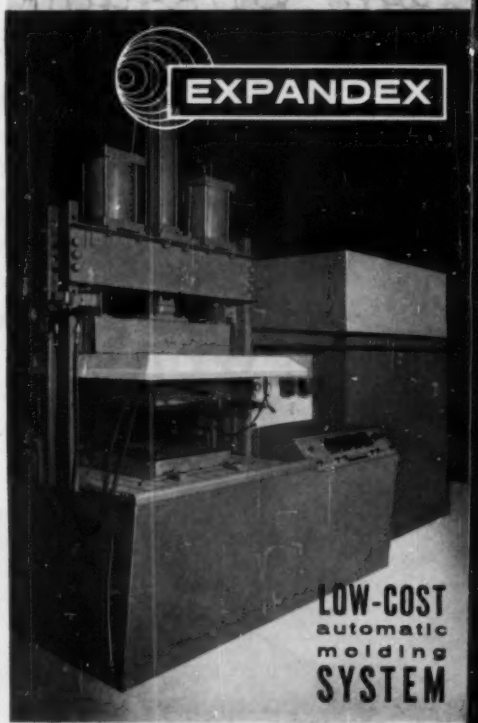
A low-cost, automatic molding system to produce high-quality expandable polystyrene products is now available. This system is compact. It saves floor space. Yet, it combines all the equipment needed for high production molding. Included is a 50-ton vertical press, hot-air pre-expander, compact steam generator, vacuum pump, and central control console. And, because Expandex Corp. is also experienced in custom molding, the EX-2 System has been thoroughly tested in use.



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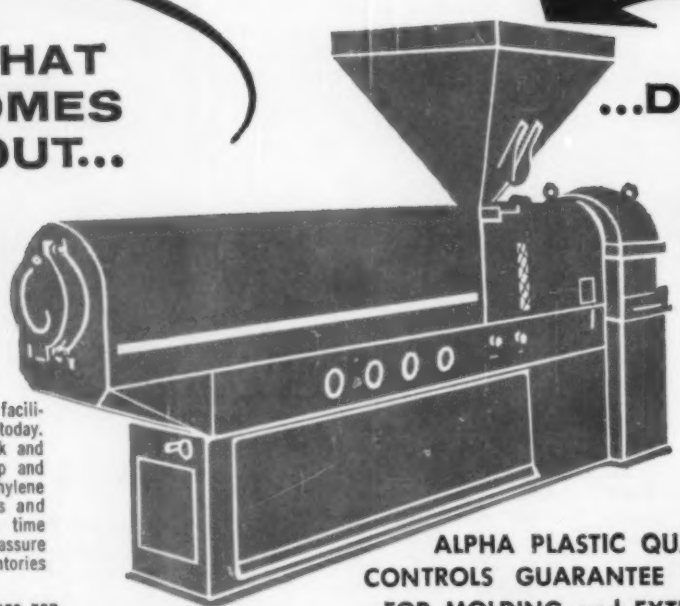

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THE PLASTISCOPE

(*From page 189*)

the exclusive license for a patent-pending process for electronic high-frequency molding of expandable polystyrene. This system becomes an addition to their standard line of equipment. Tronomatic also produces heat-sealing machinery.

National Distillers and Chemical Corp. has merged with **Bridgeport Brass Co.,** which will operate as a division of National. The growing relationship between metals and polyolefins was a major factor motivating the merger. One area of interest is polyethylene-coated metals. **Austin R. Zender,** who becomes a member of National's board of directors, continues as president of **Bridgeport Brass Division.** On a combined basis, sales of the two companies exceeded $720 million, and assets were more than $625 million in 1960.

Chemsol Inc., Elizabeth, N. J., has purchased from **Interchemical Corp.,** a 90,000-sq.-ft. plant in Newark, N. J. The building formerly housed the Coated Fabrics Cotan Div. of Interchemical, and will now be used by Chemsol for expanded operations of its Plastics Div., which is headed by **George Terpak Jr.,** vice-president of Chemsol.

Hauser Products Inc., custom molder, has moved from Kolmar Ave. to new and larger quarters at 1757 N. Kimball Ave., Chicago, Ill. Plant and offices occupy 40,000 sq. ft., doubling operating and storage facilities. The new plant also houses the firm's mold-making subsidiary, **Paramount Die Mold Co.**

Midwest Plastic Products Co., extruder of plastic sheet materials, has consolidated its plant and offices in a move to a new 30,000-sq.-ft. building at 3251 Chicago Rd., Steger, Ill. The company has also installed additional new equipment.

Nopco Chemical Co. has opened a new urethane foam producing and fabricating plant at Chattanooga, Tenn. Encompassing 70,000 sq. ft., with an initial capacity to produce more than 4 million lb. of foam annually, the new plant is one of a series of Nopco facilities expansions planned for 1961.

Borg-Warner Corp. has acquired a controlling interest in **Fibermold Corp.,** Gardena, Calif., for its **Ingersoll-Humphryes Div.** Under the terms of the agreement, Fibermold becomes a subsidiary of Borg-Warner. Fibermold is a fabricator of thermosetting plastics products, including shower stall receptors, juvenile furniture, chairs, and outdoor furniture. Ingersoll-Humphryes has been sales agent for Fibermold's shower receptors.

The Davidson Rubber Co., manufacturer of polyurethane products, has under construction a new 100,000-sq.-ft. building at Dover Industrial Park, N. H., scheduled for completion in September. The company currently operates two factories, employing 500 persons. **Coleman F. Hogan** is president.

Mt. Clemens Metal Products Co., Mt. Clemens, Mich., has purchased **Andover Industries Inc.,** Andover, Ohio, producer of decorated injection-molded plastic parts for automotive, radio, television, and appliance industries. The new acquisition, purchased from **Erie Resistor Corp.,** Erie, Pa., will be operated as a wholly-owned subsidiary of Mt. Clemens.

Coming events

Plastics groups

Sept. 12: S.P.E. Central Indiana Section, Retec, "Plastics for Tooling," Hotel Severin, Indianapolis, Ind.

Sept. 22-Oct. 1: International Plastics Fair, Copenhagen, Denmark. Contact: Int. Plastics Fair Secretariat, 10 Puggaardsgade, Copenhagen.

Oct. 12, 13: S.P.I. 17th Annual New England Section Conference. Wentworth-by-the-Sea, Portsmouth, N. H.

Oct. 17-19: The Plastics Show of Canada, Canadian National Exposition, Toronto. Contact: W. B. Pryde, Show Manager, 481 University Ave., Toronto, Canada.

Nov. 1-3: S.P.E. 1st Southwestern Packaging Exhibition in conjunction with North Texas Section, S.P.E., Retec on "Plastics in Packaging," Sheraton-Dallas Hotel, Dallas, Texas.

Other groups

Sept. 5-8: American Chemical Society, Chicago Section, 11th National Chemical Exposition, International Amphitheatre, Chicago, Ill.

Oct. 9-11: Technical Assn. of the Pulp & Paper Industry (TAPPI), 16th Plastics-Paper Conference, French Lick-Sheraton Hotel, French Lick, Ind.

Oct. 18-20: Packaging Institute 23rd Annual National Packaging Forum, to be held at Biltmore Hotel, New York, N. Y.—**End**

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by JAMES O. TURNER
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The author also shows how alkyd resins can be modified with other materials to produce a wide range of properties. The end products containing alkyds, *i.e.*, paints, are discussed, and recent advances in the entire field are well covered.

This book will prove of great interest to workers in the protective coatings field, suppliers of raw materials, producers of resins and coatings, and all users of protective coatings.

CONTENTS: Introduction — General Properties — Chemistry — Raw Materials — Alkyd Calculation — Manufacture — Polymer Properties — Alkyds — Modified Alkyds — Alkyds Modified with Monomers — Alkyds Blended with Other Materials — Miscellaneous Alkyds — Recent Alkyd Developments — Non-Coating Applications — Future of Alkyds.

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COMPANIES...PEOPLE

Firms and personnel in the news—what they're doing . . . and where

Union Carbide Plastics Co.; William B. Humes, former v-p, appointed pres. He joined Union Carbide in 1944 at Oak Ridge, Tenn. During the time he has been with the corporation he was a v-p of **U. C. Canada Ltd.,** and dir. of tech. planning for **U. C. Corp.**

W. B. Humes

Dr. Gilbert I. Addis appointed asst. dir. vinyl planning, Development Dept., with headquarters at Bound Brook, N. J. **Richard L. Garrison** appointed asst. regional mgr. and **Harry J. McGowan** assigned as special sales rep. in the North Central sales region with headquarters in Detroit, Mich. **W. Kenneth Hill** named tech. sales rep., New England sales region, in the Boston, Mass. dist. office.

Monsanto Chemical Co.—Plastics Div., Springfield, Mass.: **Chester L. Jones** appointed dir. of marketing. **Richard T. Clark** named dir. of sales, vinyl products.

Organic Chemicals Div.: Clifford S. Heathcote and **James D. Wright** appointed industry sales mgrs. for resin materials, and for plasticizers and rubber chemicals, respectively, in the New York dist. sales office. **C. Richard Groninger** appointed dist. sales mgr., and **James F. Compton** named senior sales rep., Pittsburgh office.

Monsanto Canada Ltd.: Peter R. Boon appointed to Plastics and Resins Tech. Service Dept. **Garth E. Johnston** named plastics sales rep.

Owens-Illinois Glass Co. has opened a new blown plastic bottle plant at 2122 Hereford St., St. Louis, Mo. **Norman E. Meese** is plant mgr.; **Harry R. Wonders** is production supv. and **William M. Grable,** admin. supv.

Mfg. Chemists' Assn. Inc., Washington, D. C.: **W. H. Salzenberg,** gen. mgr., polychemicals dept., Du Pont Co., and **T. T. Miller,** pres., **W. R. Grace & Co., Polymer Chemicals Div.,** named chrmn. and v-chrmn., respectively, of the Plastics Committee.

American Society for Testing Materials, Philadelphia, Pa.: **Alfred C. Webber,** asst. lab dir., **R & D Div., polychemicals dept., Du Pont Co.,** elected v-p. New board members include **Albert G. H. Dietz,** prof. of bldg. engineering, **Mass. Inst. of Technology; Bruce W. Gonser,** tech dir., **Battelle Memorial Inst.; Wayne A. Kirklin,** mgr., **Analytical Div., Hercules Powder Co.;** and **Gordon M. Kline,** chief, **Organic and Fibrous Materials Division, National Bureau of Standards.**

The Richardson Co., Melrose Park, Ill.: **Dr. Stephen J. Groszos** named tech. dir., and **Ramon A. Mulholland** appointed dir., commercial development, R & D Div.

The Dow Chemical Co.: Donald K. Ballman named v-p for marketing, purchasing, and distribution. **Edward R. Nepkie** appointed commercial mgr. and a dir. of **Dow-Unquinesa S.A.,** Bilbao, Spain. He is succeeded as dist. sales mgr. for plastics in the N. Y. office of Dow Chemical by **Guy W. DeKuiper.**

Dobeckmun Div.: W. B. Sander appointed to newly created position of West Coast production mgr. He will be responsible for production at the Berkeley plant, which produces transparent flexible packaging materials, and the PE extruding operations in Fresno, Calif., and **Hawaiian Extruders Inc.,** Hawaii. **William C. Mertz** promoted to project engineer for film development.

FMC Corp. is the new name of **Food Machinery & Chemical Corp.** because, according to FMC Chrmn. **Paul L. Davies,** the term "food machinery" as the chief descriptive element in the name contradicts the full scope of the company's activities.

Dapon Dept.: Clinton J. Starke appointed central dist. sales mgr. responsible for sale of diallyl phthalate resin and industrial laminates.

U. S. Industrial Chemicals Co., Div. of National Distillers and Chemical Corp.: Dr. Aimison Jonnard named mgr. of market research and development. He joined U.S.I. in 1959 as asst. mgr., polymer planning and applications.

Dr. Jonnard

Antonio T. Chong named asst. production mgr., polyethylene resins. He will be responsible for coordinating production of PE at U.S.I.'s plants at Tuscola, Ill., and Houston, Texas, and for integrating PE raw materials needs of all divs. of National Distillers.

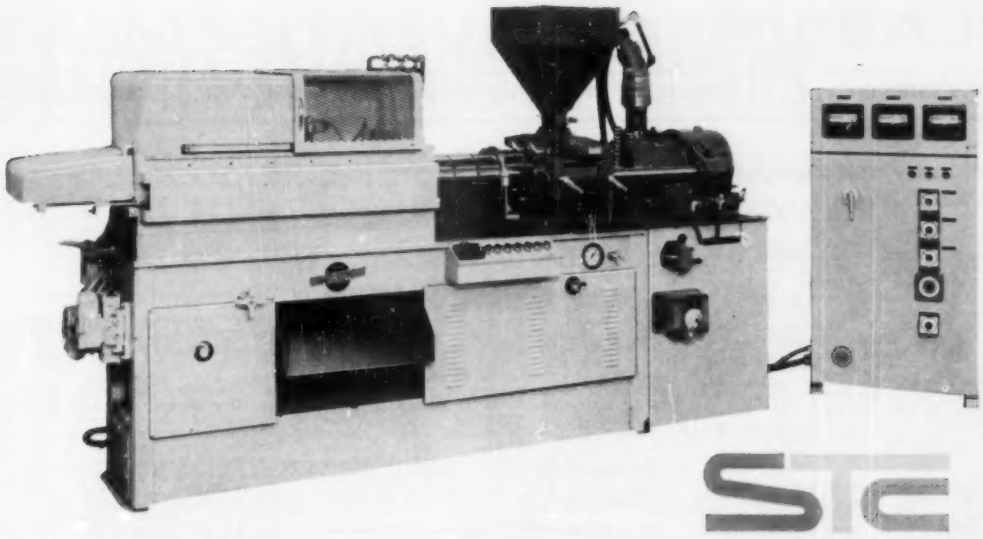
Celanese Corp. of America has consolidated administration of its foreign activities in a subsidiary, **Celanese International Corp.: Richard W. Kix-Miller,** exec. v-p international operations of the parent organization, will serve also as pres. of the subsidiary. **Fletcher Horn** appointed v-p and asst. to pres.; **Harrison C. Givens Jr.** and **Robert L. Mitchell,** v-ps; and **Dr. Howard L. Pilat,** asst. v-p.

Allied Chemical Corp.—National Aniline Div.: R. M. Welch assigned to Philadelphia, Pa. sales branch, responsible for sales of company products in Northeastern Pa. **Joseph C. Dillon** named Midwest sales rep. for urethane chemicals, in Akron, Ohio branch, and **James K. Merwin** appointed field sales rep. for urethane chemicals, intermediates, and resin chemicals, in Charlotte, N. C. branch.

United Plastics Distributors Assn. has established offices at 2217 Tribune Tower, Chicago, Ill. **Minita Westcott** is managing dir. of the assn.

Cadillac Plastic & Chemical Co., Detroit, Mich.: **George C. Barber** has been named mgr. of the Akron, Ohio, warehouse and sales office.—**End**

A VISIT TO THE BOOTH of R. H. Windsor Ltd., manufacturers of injection molding and extrusion machines, is made by The Viscount Hailsham P. C., Minister of Science (far right), after the official opening of Interplas-61 plastics exposition in London on June 21. With him (left to right) are Finlay Walls, Chairman of British Plastics Federation, the three principals of R. H. Windsor Ltd.—Peter C. Windsor, R. E. G. Windsor, and Gordon T. Windsor. (A full report on the show appeared in a special supplement to the July 1961 issue of MODERN PLASTICS.)



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FOR SALE—(1)—Thropp 2-Roll Mill 18" x 50", 6" x 12", 2" x 6", complete with motors; (2)—Cumberland #18 and #½ Granulators with motors; (3)—Baker Perkins 50, 100 and 150 gal. Sigma blade jacketed Mixers; (1)—P-K 1 cu. ft. 304 SS "V" Blender; (3)—Mikro Pulverizers, Bantam, 1SH and 1SI; (5)—Stokes Preform Presses, models R, T, DD2, DDS2 and D4; partial listing, send for details. Brill Equipment Company, 35-55 Jabez St., Newark 5, N. J. Tel: MArket 3-7420.

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FOR SALE—AUTO-VAC Mark 1 pressure former; 23" x 29" forming area complete with indexing feed of our design to .005"; used approx. 100 hrs.; built in late 1959. For full details contact Mr. McDonald, Guild Plastics, 32 Potter St., Cambridge, Mass., UN 8-7400.

FOR SALE—Baker-Perkins #16-UUEM, 150 gal. jacketed dispersion mixer, 150 HP XP drive, Vaulted cover; 100 gal. Baker-Perkins T347SS jacketed dispersion blade mixer; Baker-Perkins 200 gal. jacketed sigma-blade mixers; 200 gal. and 500 gal. stainless jacketed reactors; 1350 gal. T347 stainless jacketed resin kettle; American 42" x 120" dbl. drum dryer. ASME code, stainless trim; 2600 gal. T316 stainless pressure tanks, coils, dished heads; 1800 gal. T316SS jacketed and agit. resin kettle; 800 sq. ft. T316SS shell and tube heat exchangers; Baker-Perkins #15-UUMM, 100 gal. jktd. dispersion blade mixer, 100 HP; Worthington 70 cu. ft. rotary blender; we pay cash—top dollar—for surplus equipment. Perry, 1429 N. 6th St., Phila. 22, Pa.

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THE MAGIC NUMBER FOR MIRACLE EQUIPMENT "BUYS" IS STerling 8-4672 F-B Banbury Mixers #00, #11 Unused 2 Roll Mills, 14" x 30" F-B Mills, 18" x 54", 22" x 60" 3 Roll Calenders, 6" x 18", 22" x 60" Hartig 4½" and 6" Extruders. NRM 2½" Oil Heated Extruder. Welding Engrs. 2" Twin Screws. Royle 2" & NRM 1½" Extruders B. & J. Rotary Cutters; 3 sizes Stokes 150 Ton Molding Press Hydr. Rubber Cutter, 30" Wide. Hydr. Presses, 7 to 500 Ton. Preform Presses, Autoclaves, Ball Mills, Blenders, Dryers. First Machinery Corp., 209-289 Tenth St., Bklyn. 15, N. Y. STerling 8-4672. Cable: "Effemcy".

PLASTIC PREHEATERS for sale: 10 KW Westinghouse & 5 KW G.E., also Girdler Dielectric Drying or Baking Oven and Stokes 300 ton Upstroke Hyd. Press Model 250A. Universal Machinery & Equipment Co., 1630 N. 9th St., Reading, Pa. FRanklin 3-5103.

BLOW MOLDING SET UP—2" Kato, one year old, complete with all controls and blow molding equipment. With variable speed drive. 2½" Sterling, long barrel, used less than one month. With complete blow molding set up and all controls. Injection Molding Machines—4 oz. Moslo, 4 oz. Harvey, 8 oz. Reed Prentice, 12 oz. DeMattia, 12 oz. Reed Prentice. All in stock. Immediate Delivery. 2200 Ton Birdsboro Heavy Duty Laminating Presses. Bed size 7' by 5'. Each press contains two 25" diameter rams. Complete with intensifiers for 4000 P.S.I. Stokes Model R Single Punch Tablet Press, with vari speed drive. 6" Hartig Extruder, 16,5:1 Electrically Heated Barrel. Complete with all controls and motor drive. 1" NRM Lab Extruder, complete with drive and controls. Scrap Grinders—1½ HP up to 50 HP available. We have a full line of Laminating Presses, Molding Presses, Mills, Calenders, Extruders, Injection Molders, Scrap Grinders, Coating Equipment and other accessories for the plastic industry. We will finance. Johnson Machinery Company, 90 Elizabeth Ave., Elizabeth, New Jersey, ELizabeth 5-2300.

FOR SALE—Reed Prentice 4 oz., Model 5A4 New 1951 Serial 60019. Perfect condition, very clean. Complete with all controls $4000.00. Wahl Clipper Corp., Sterling, Illinois.

FOR SALE—(1)—150 ton Baldwin Southwark self-contained compression molding press; (2) Stokes preform presses, models R and T; (1) Hartig 2" electrically heated plastics extruder; (1) Stokes model 741 75 ton automatic molding press; (1) Watson Stillman 1 ounce vertical injection molding machine. Chemical & Process Machinery Corp., 52 9th Street, Brooklyn 15, N. Y., HY 9-7200.

FOR SALE—500 ton W-S hobbing press. 500 ton Utility five 48"x30" platens. Four 300 ton Molding Presses various makes. HPM 200 ton downstroke. Watson Stillman 240 ton, ten 24"x56" platens. W & W 200 ton, 24"x42". Stokes Standard 50 ton semi-automatic. D&B 150 ton, 25"x25". French Oil 120 ton self-contained. 120 ton upstroke, 29"x21". 50 ton Birdsboro 24"x20" Stokes 15 ton automatics. Hydraulic pumps and accumulators. MPM 3½" wire covering Extruder. New ¾" plastic extruder. Other sizes to 6". Seco 6"x12" 2-roll Mills and Calenders. Farrel & Thropp 40" & 48". Other sizes to 60". 60" Spreader Heads with XP motors. Despatch electric heated ovens and other types. New ¾ oz. Bench Model Injection Machines. Van Dorn 1 and 2 oz. Other sizes up to 100 oz. Baker-Perkins and Day jacketed Mixers. Taylor-Stiles Pelletizer, 3 HP. Plastic Grinders. Stokes & Colton Preform Machines. Partial listings. Send for Bulletin #192. We buy your surplus machinery. Stein Equipment Co., 107-8th Street, Brooklyn 15, New York. STerling 8-1944.

MOST MODERN PACKAGING AND PROCESSING MACHINERY Available at Great Savings. Baker Perkins, W. & P. and Day Double Arm Steam Jacketed Heavy Duty Mixers—25, 50, 75 and 100 gal. capacities. Day, Robinson 50 to 2,000 lbs. Dry Powder Mixers, Jacketed and Unjacketed. Also wood and Enamel. Devine (Porter) 650 gal. Steam Jacketed Double Spiral Mixers. B. P. 100 gal. Stationary Vacuum Double Arm Mixer. Day Imperial 50 and 75 gal. Double Arm Mixer, Sigma, Dispersion Blades. Mikro No. 6 Stainless Steel Atomizer with Collector. Mikro Pulverizers, Models Bantam, 1SH, 2DH (S.S.), 2TH, 3TH and 4TH. Fitzpatrick Models D and K-7 Stainless Steel Comminuters. Colton Models 241 and 260 Double Rotary High Speed Tablet Presses. Stainless Steel Jacketed Double Action Mixing Kettles 100 and 150 gal. capacities. Package Machinery, Hayssen, Scandia, Wrap King, Campbell, Miller Wrappers. Cartoning Machines—Ceco, Pneumatic Scale, Jones. Union Standard Equipment Company, 318 Lafayette Street, New York 12, N. Y. Phone: CAnal 6-5333.

FILM COATING EQUIPMENT FOR SALE: One 72" Tandem Coating Line for applying Aqueous Emulsions and Solvent Coatings to thin films. This equipment designed to provide for Two-Side Coating and Drying of Water Base and similar coatings using "Waldron Microjet" method of application, and also for coating, drying, and deodorizing of solvent type coatings using "Waldron Reverse Roll Method" of application. Included are Two Waldron Reverse Roll Coaters, Two Waldron Uniflow Microjet Coaters, Two Three-Roll Felt Blanketed Suction Devices, One J. O. Ross Double Straight Pass Dryer, one section above the other, integrally designed by independent with respect to air distribution and control in their entirety. Dryer is approximately 30' over-all in length. Designed for web widths up to 72" and speeds up to 300 feet per minute while using solvent. There are three zones of independent air supply and control for each dryer. Fans, heaters, drives and controls for above. This equipment is in good condition and was purchased in 1956 at cost of approximately $191,000. Drawings and further details are available upon request. Reply Box No. 6981, Modern Plastics.

PRESSES—24" x 54" 8 Openings; Elms—500 Ton 42" x 42", 36" Stroke, with Pull Backs; 6—24" x 24"; 60" x 60" Press, 2 Rams; 2—H.D. Wood Embossing Presses, Electric Platens, complete with pumps. Baker-Perkins #15-UUMM, 100 gal. jkted. dispersion blade mixer. Brewster Rubber Machinery Co., 349 E. Exchange St., Akron, Ohio; FRanklin 6-2911.

HIGH FREQUENCY HEAT GENERATORS—one thermex 7. K. W., 19.1 MC. grid size 14" x 20". One thermex 15 K. W., 13.7 MC, grid size 23" x 26". All units complete and for operation on 220 Volt. 60 Cycle. 3 phase. Good Condition. Standco Supply Co., 2701 Clinton Dr., Houston, Texas.

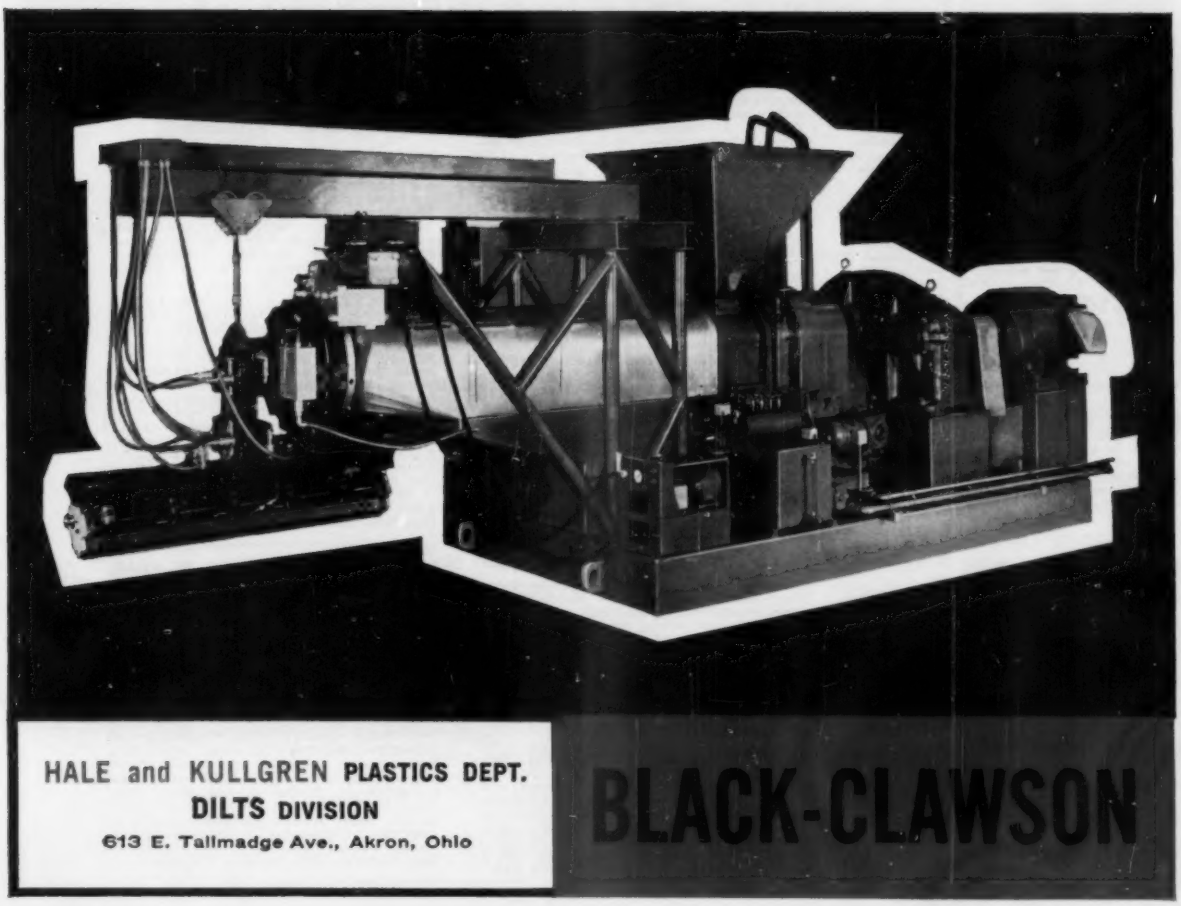
FOR SALE—CUMBERLAND #20 Grinder. 8"x20" throat opening complete with 75 HP motor and starter. All in excellent working condition. Also, completely rebuilt 50 HP U.S. Varidrive, equal to new. Marval Industries, Inc., 711 So. Fulton Ave., Mount Vernon, N. Y. FA 4-0616.

(Continued on page 196)

AETNA-STANDARD EXTRUDERS

are induction-heated and water-cooled for precise temperature control **/ have floating screw and self-cleaning valve for** flexible pressure control **/ are well instrumented for** optimum operator control.

They operate trouble-free around the clock and save money in terms of increased production and less scrap on extrusion coating, laminating, blown or flat film production. 1½" to 8" ... Up to 10,000 psi ... 20:1 to 29:1 L/D ratios. Output Rates to 2000 Lbs/Hr on extrusion coating. Lab models, too. **Write or call for Bulletin HK-10.**



HALE and KULLGREN **PLASTICS DEPT.**
DILTS DIVISION
613 E. Tallmadge Ave., Akron, Ohio

BLACK-CLAWSON

(Continued from page 194)

INJECTION MOLDING—HPM 9 oz; Hydraulic Press, French oil semiautomatic 100 ton; Mill-Farrell 16x36; Baker Perkins SS 100 Gal 2 Arm Jac. vac. Hyd. tilt 50 HP; 150 Gal Day Imperial Sigma; 3 Baker Perkins 100 Gal Sigma Jac. Hyd. tilt; SS tanks-2-11,000 gal-1-5700 Gal; Extruder 8" elec. heated; Ram extruder: Machinecraft Corp., 800 Wilson Ave., Newark, N. J. MI-2-7634.

FOR SALE—Elec. extruders 1" N.R.M., 2" National Erie, 3½" Hartig comp. with wire covering line, 6" Royle, 6" National Erie. 3" x 8" Thropp lab mill. Model R Scott tester. Thropp 16" x 40"—60 H.P. 215 Cu Ft s/s blender jac. Keith Machinery Corp., 73-15th Street, Brooklyn, N. Y. St 8-5502.

Machinery Wanted

USED THREE ROLL MILL—High speed-heavy duty-water cooled-explosion proof-rolls to be 4½" x 10" or larger and made of stainless steel. Would like unit with two speed motor, hydraulic roll adjustment, pressure gauges, temperature gauges for each roll, etc. If available. Reply Box 7000, Modern Plastics.

Materials For Sale

FOR SALE—13,000 lbs. White C/A pellets, also standard colors; 20,000 lbs. butyrate standard colors; 15,000 lbs. virgin standard medium blue H.I. PS, also standard colors; 25,000 lbs. natural nylon 101 reground, A and C grade; 10,000 lbs. jet black EC pellets. Reply Box 6999, Modern Plastics.

Materials Wanted

GET THE TOP MONEY FOR PLASTIC SCRAP—Now paying top prices for all thermoplastic scrap. Wanted: polystyrene cellulose, accetate, vinyl, polyethylene, butyrate, acrylic nylon. All types and forms including rejects and obsolete molding powders. Fast action wherever you are located. Write, Wire, Today! Reply Box 6980, Modern Plastics.

WANTED — PLASTICS OF ALL KINDS — virgin, reground lumps, sheet and reject parts. Highest prices paid for styrene, polyethylene, acetate, nylon, vinyl, etc. We can also supply virgin and reground materials at tremendous savings. Address your inquiries to: Goldmark Plastic Compounds, Inc. 4-05 26 Ave. Long Island City 2, N. Y. RA 1-0880.

POLYVINYL BUTYRAL SCRAP WANTED. We are seeking a steady source of supply for clear polyvinyl butyral scrap. Send samples or contact, Technical Director, Cellofilm Corporation, Wood-Ridge, New Jersey. Phone: GEneva 3-7100.

Molds Wanted

MOLD WANTED—Used polished mold for experimental research with resins for matched metal molding of reinforced plastic. Must have 6 inch minimum depth and flat section for destructive testing. Send description and price to Box 6993, Modern Plastics.

Help Wanted

SALES ENGINEERS—Aggressive extrusion machinery manufacturer seeks sales engineers to work out of Metropolitan N.Y. home office. Knowledge of thermoplastics and experience in machine sales desirable. Submit resume in confidence to Sales Manager, Box 6985, Modern Plastics.

PACKAGING ENGINEER—Opening for creative mechanical-electro processing engineer with experience in vacuum forming packaging. The growth opportunities merit the serious attention of an aggressive engineer interested in modern packaging techniques and personal advancement. Send complete background which will be kept in confidence. New York area. Reply Box 6986, Modern Plastics.

SHEET EXTRUSION FOREMAN—All-around plastics production man to run new German extrusion sheet line on a 24-hour basis. Excellent growth potential. Stamford, Conn. Reply Box 6996, Modern Plastics.

SALES MANAGER—Vacuum Forming. We extrude our own sheet and need a really outstanding man thoroughly experienced in this field to create items and national sales force. Excellent salary and many benefits. Reply stating past responsibility and salary earned. Box 6984, Modern Plastics.

TOOL DESIGNER—Growth opportunity with well established proprietary molder for man with heavy experience in plastic injection mold design. Knowledge of modern molding machines desirable. Send resume, include salary required to Sterling Plastics Co., 1140 Commerce Ave., Union, N. J.

PLASTIC EXTRUSION ENGINEER — Capable of Managing Film Extrusion plant of fast-growing, nationally known company. Minimum 3-5 years experience in production or development. Excellent opportunity for professional growth and rapid advancement. Salary open. Send resume to: Box MP 228, 125 West 41st St., N.Y. 36, N.Y.

PETROCHEMICAL SALES — Our expanding operations require the immediate employment of two technical sales representatives with 2—5 years experience in field sales. Locations—New York area and Chicago area. Requirements—chemical or chemical engineering degree, experience in sales of chemical intermediates preferably to plasticizer and plastics industries. Send resume to Mr. A. J. Lacazette, Manager Plastic Intermediates Sales, Petrochemical Department, Continental Oil Company, 1270 Avenue of the Americas, New York 20, New York.

SALES REPRESENTATIVE WANTED—Prefer man with technical background and experience in sale of materials or equipment to molders of thermosetting plastics. Established manufacturer of industrial dielectric heating equipment has area within 200 mile radius of central Ohio now available. Compensation arrangements open. Send complete resume, recent photograph and compensation expected. W. T. La Rose & Associates, Inc., Troy, N.Y.

REPRESENTATIVES WANTED — Territories open to represent the Trueblood Unimatic Injection Molding Machines and Tooling for molding electric cord plugs—loose inserts—and nylon parts. Write giving particulars to: Union Tool & Engineering Company, 332-336 Jones Street, Dayton 10, Ohio.

PLASTICS SALESMAN — Chicago company seeks a man with thermoplastic sales experience. Excellent opportunity in rapidly expanding organization for a man with enthusiasm and drive. We supply color concentrates, colored thermoplastic resins and pigments for injection molders and extruders. Thermo Plastic Materials, Inc., 2929 N. Campbell Ave., Chicago 18, Illinois.

PLASTICS ENGINEER—Expanding plastics manufacturing company located in the southern part of the Midwest and distributing nationally seeks graduate mechanical engineer with 0-5 years experience for opportunity in process and product development and technical sales service areas. Submit resume and salary requirements to Box 6989, Modern Plastics.

WANTED—MANUFACTURERS REPRESENTATIVES. Established extruder of tubing and profiles in thermoplastics expanding custom operation. Requires experienced representatives in plastics field calling on O.E.M. accounts in Minneapolis, St. Louis and Detroit areas. Commission basis. Midwest location. Include details on background, other lines handled and current territory covered. Reply Box 6994, Modern Plastics.

WANTED—TOOL DESIGNER for Compression, Transfer and Injection molds. Must have had several years experience, and at least two years of college. Excellent pay and working conditions. Located in Western Pennsylvania. Reply Box 6995, Modern Plastics.

WANTED—Project Engineer or Technician with flexible Ureathane foams and Plastisol Rotational Skins for interesting work in automotive field with established Plastic Firm in Michigan area. Reply Box 7002, Modern Plastics.

PLASTICS ENGINEERS—Immediate openings in our new Research and Technical Service Center for Engineers familiar with polymer evaluation. We require a Bachelor's Degree and 3 to 10 years experience in plastics processing, physical testing, and/or customer service, particularly in polyefins and polystyrene. Employment will offer challenging opportunities in applications research, technical service and resin investigation. Location in pleasant suburban Northern New Jersey. Please send detailed resume with salary history and requirements. All replies held in strictest confidence. Reply to Rexall Chemical Company, Dept. KK, P. O. Box 37, Paramus, New Jersey.

PLASTICS ENGINEER with 3 to 5 years experience in thermo-plastics wanted to supervise operation of a new sheet extrusion program and to undertake R&D projects. This is a progressive, growth company in plastic and boxboard packaging offering a promising future. Attractive New England area. Applications will be kept confidential. Please submit complete resume, including compensation history and requirements to Box 6998, Modern Plastics.

Situations Wanted

MACHINERY MAKER in the West German Republic, with modern machines for drilling and gear cutting, vast experience in single and mass production, is interested in entering the field of plastics processing machinery construction, especially injection and molding machines. Prefer licensing arrangement. Please send offers to Box 6992, Modern Plastics.

SALES ENGINEER—BSME, PE, available in several weeks to one or more employers on part time or full time basis. Twelve years of broad experience in manufacturing. Good knowledge and understanding of the problems in industry, the orientation and motivation of its key men. Has the perception of an engineer, the dedication of a manger. Able to resolve facts, cut through confusion, eliminate irrelevant intangibles and focalize on your product or service in its right place in the customer's operation. Prefers to locate in N. J. Reply Box 6978, Modern Plastics.

SALESMAN — INTERESTED IN PLASTICS. Seeks to join aggressive firm in the plastics field selling to Industrial accounts. Experienced dealing with O.E.M., Mfgrs. of toys, housewares, hardware, furniture, etc. Can develop new outlets for prospective company in the New York Metropolitan area and New Jersey. Reply Box 6997, Modern Plastics.

FOREMAN—twelve years' experience as injection molding foreman, including maintenance, machines and molds. Some experience with rigid PVC. Available immediately. Prefer metropolitan area New York City but will consider relocation. Solid mechanical background. If you are looking for a capable, industrious, honest and loyal man, write to Box Number 6982, Modern Plastics.

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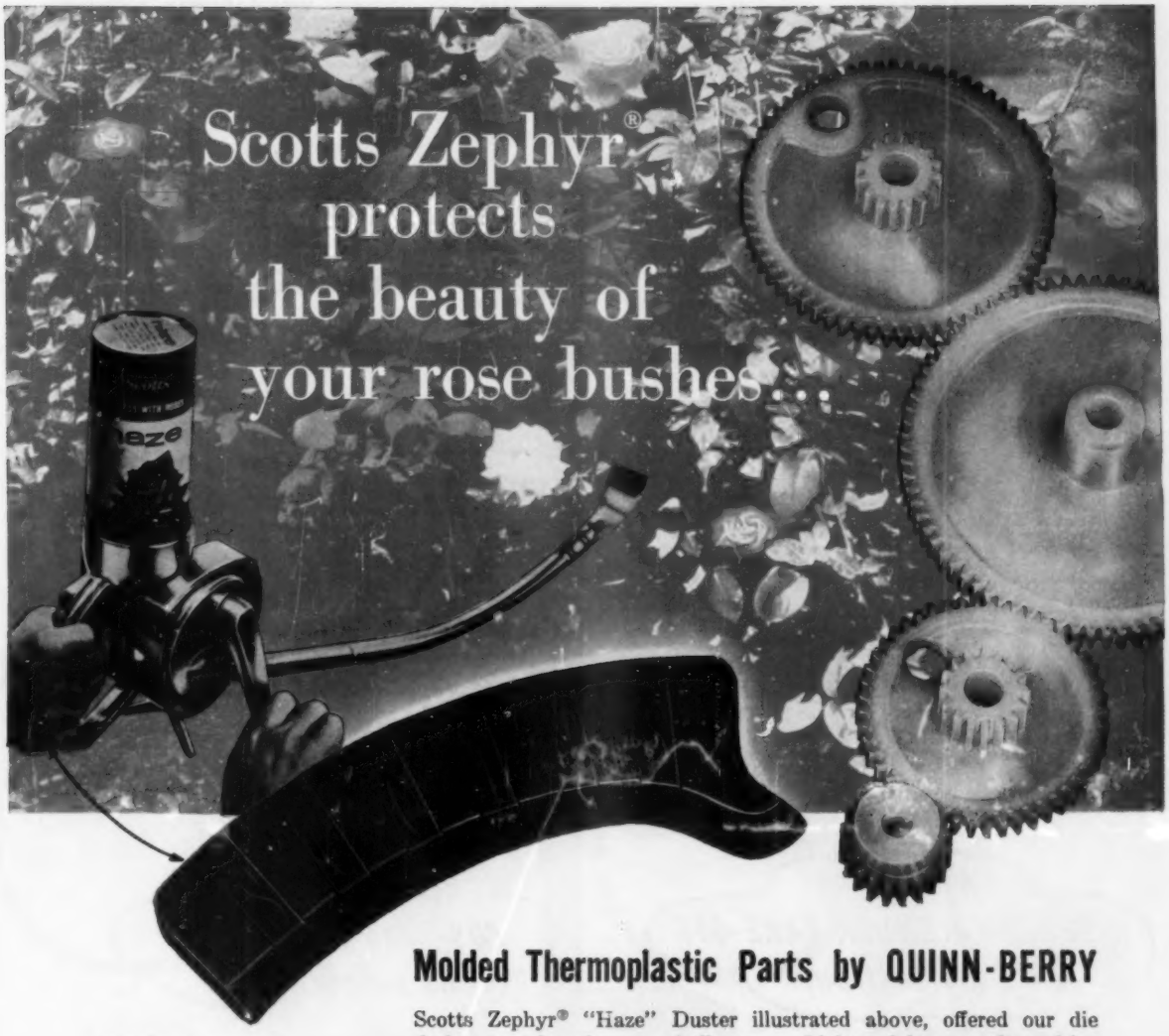

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(Continued from page 196)

MANAGEMENT — Chemical Engineer. Eighteen years proven accomplishments as plant manager, assistant plant manager, plant superintendent, production superintendent, head of quality control, head engineering dept. Experienced chemicals, fats and oils, foods, monomeric and polymeric plasticizers-esters, fatty acids, alcohols, sulfuric acid, adhesives, vitamins, dry-wet milling. Reply Box 6983, Modern Plastics.

SALES-FRP-BUILDING PRODUCTS — Aggressive Salesman desires position with responsible company that is looking for it's share of the Construction Dollar. The construction industry demands plastic building material, but it has to be sold on YOUR product. Years of success have taught me how and I can do the same for you. Reply Box 6988, Modern Plastics.

COATED FABRIC CHEMIST or Production Superintendent. Extensive experience in research and development of all types of protective coatings on natural and synthetic fabrics. Strong background in plant coating industrial nylon fabrics with Vinyl, Silicone and Hypalon. Considerable experience in cost control, quality control and production supervision. Reply Box 6991, Modern Plastics.

REINFORCED PLASTICS—Management, product planning, marketing, tech service, sales or other responsible position benefitted by ten years product design, tool design, production, development, and sales experience and education in reinforced plastics. AB, MA, and MS degrees. Wide interest in the field, and mature creative approach to the economic problems in competition with other materials. Reply Box 6990, Modern Plastics.

Business Opportunities

BUSINESS OR PARTNERSHIP WANTED —Chemical Engineer will invest capital and services in proposed or established business in or related to plastics industry. Prefer partner with sales or marketing background. Northeast. Reply Box 6979, Modern Plastics .

WELL-KNOWN DUTCH plastic industry seeks contact with American industry for the manufacturing of expanded P.V.C. cloth, packaging, toys etc. Either under license or on combined efforts basis, for the fast growing E.E.C. markets. Please contact us and write Box Number 1695 Advertising Agency Van Gelderen, P.O.B. 826, Amsterdam, Holland.

WILLING TO INVEST experience and money in active going Plastic concern in Los Angeles area. Reply Box 7001, Modern Plastics.

LEADING GERMAN MANUFACTURER of screw plasticizing injection machines desires licensing or manufacturing cooperation in the United States with capable machinery manufacturing company. Reply to Box 6996, Modern Plastics.

HAVE YOU CANADIAN MANUFACTURING FACILITIES? Present exchange rates and customs duties make the Canadian market difficult for U.S. based chemical makers. In our factories in Montreal and Toronto we have a great variety of chemical production facilities, and our salesmen cover all of Canada. It may be greatly to your advantage to have us make your products under a licensing agreement. We will deal only with established U.S. firms, and with principals only. If interested please write fully on one line: H. L. Blachford, Limited. 977 Aqueduct Street, Montreal 3, Canada.

Miscellaneous

SPEEDY SAMPLE MOLD SERVICE available on plastic parts such as closures, fitments, containers, dials, knobs, etc. Can work from sketches, models or give consulting service. Fully equipped 5 man tool shop with sample molding and testing facilities. Address Box 6987, Modern Plastics.

TO VACUUM FORMERS—We are interested to tie up for the Canadian market vacuum formed proprietary lines. Plastic Converters Ltd., 2310 Holt Street, Montreal, Que.

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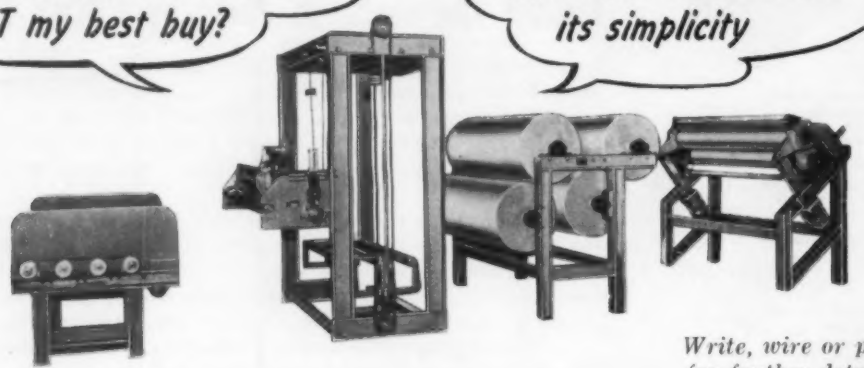

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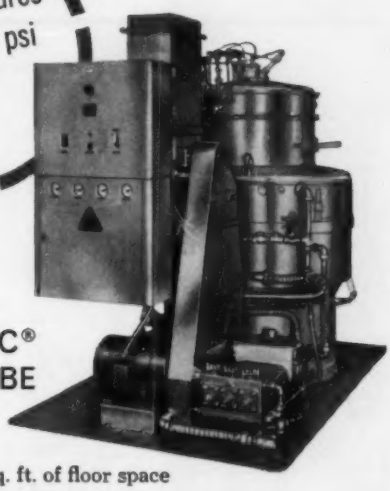

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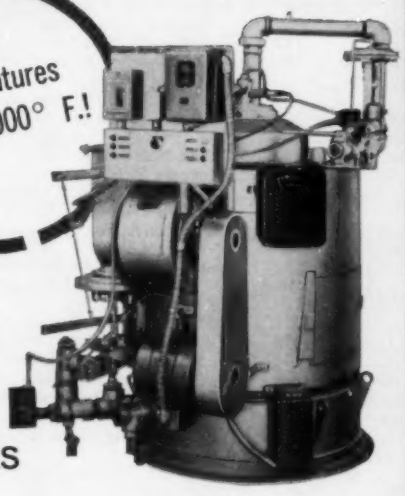

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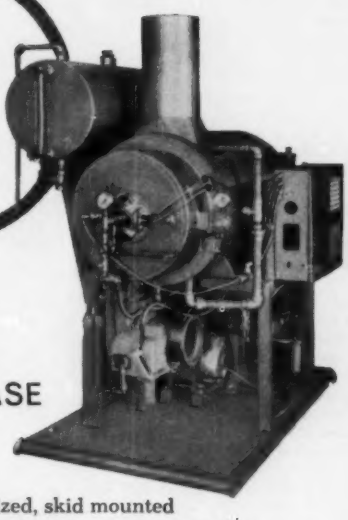

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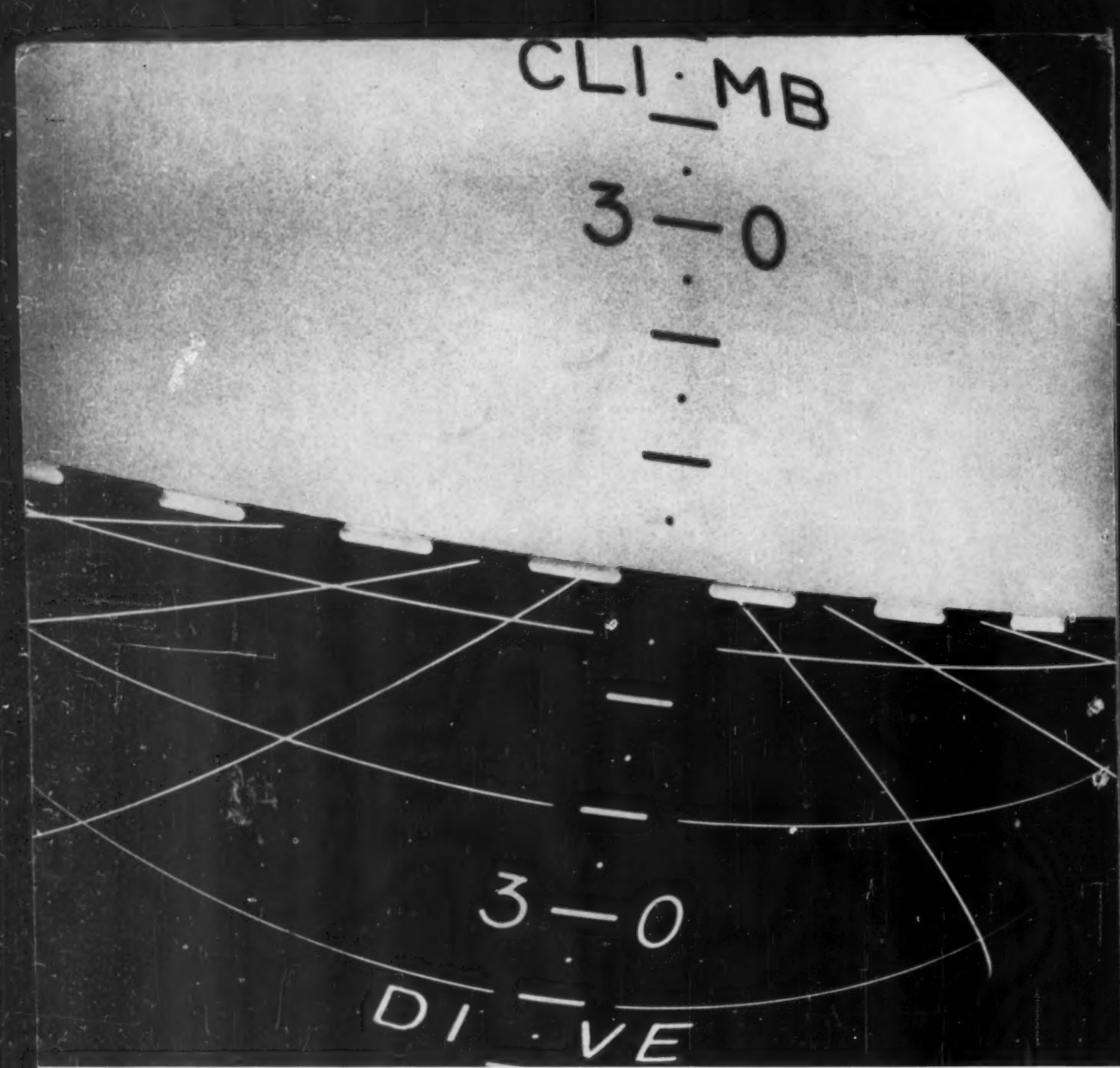

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